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Contents.

	PAGE
Surface in Service	247
Foundry Queries	248
Some Experiences with Malleable Cast Iron	249
Practical Crucible Steel Melting	253
Research and the Metal Industries	255
Correspondence	256
Semi-Steel	257
The Foundry and Railway Charges	259
Foundry Plant at the Leipzig Fair	260
Blast-Furnace Irregularities	261
Belgian Foundrymen to Meet at Brussels	262
Trade Talk	264
Iron and Steel Markets	266

Forthcoming Events.

MARCH 29.

Sheffield Metallurgical Association:—Ordinary meeting at Sheffield. "The Heat Treatment of Large Forging." Paper by C. W. Hurst.

MARCH 30.

Newcomen Society for the Study of the History of Engineering and Technology:—Ordinary general meeting in London. "Notes on Lead Mining and Smelting in West Yorkshire." Paper by A. Raistrick, M.Sc., F.G.S.

Institution of Production Engineers:—General meeting in London. Lecture on "The Development of Rustless and Allied Steels" by Dr. W. H. Hatfield.

Institute of British Foundrymen.

MARCH 25.

London Junior Section:—Ordinary meeting in London. "If I were a Moulder," Paper by Wesley Lambert.

MARCH 26.

Newcastle-on-Tyne Branch:—Ordinary meeting. "Blast Furnace Practice," Paper by C. S. Gill.

East Midlands Branch:—Ordinary meeting at Loughborough. "Sand Moulding Practice," Paper by J. D. Nicholson.

Scottish Branch:—Annual business meeting at Glasgow. "Traneport of Foundry Materials," Paper by James Arnott.

MARCH 31.

Birmingham and West Midlands Branch:—Ordinary meeting at Birmingham. "Patterns and Pattern Storage," Paper by F. J. Cook.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Surface in Service.

If we were asked to enunciate what property of a casting had the greatest commercial importance we should unhesitatingly put forward the claim of the appearance of the skin. Those making die castings, or selling the products of the semi-permanent mould, rightly stress the finish of their work. Surely the time has arrived when a nomenclature should be developed which would erase once and for all from the salesmen's vocabulary such expressions as excellent, magnificent, exceedingly smooth, and from the buyers', rotten, appalling, frightfully rough, when speaking of the surface of castings. This property of smoothness we take to be in the same category as mineralogic hardness, which has for many years been designated by numbers according to Mohr's scale. We envisage a specially adapted profiling machine which would be provided with a needle of definite sharpness, and which would give an exaggerated replica of the condition of a surface when pulled along it lightly at a fixed speed pressing at an angle of, say, 45 deg. The dimensions of the exaggerated jogs so produced would enable one to designate an art bronze surface of the highest quality, as, say, No. 1, whereas a steel casting cast in a poorly refractory sand would be classed as No. 13.

Such a machine would make experiments on moulding sand very much more interesting and useful, whilst for the manufacture of ingots, moulds and cylinders, where surface is of technical value, the results so obtained would be of the utmost importance. A query we publish elsewhere asks for details of sand-blasting conditions, yet all the makers of such machines can state is that it manifestly improves the surface conditions. They will state, with truth, that once a foundry supplies sand-blasted castings the customer will be loud in his demands for every casting he buys to be so treated. But surely it would be more satisfactory to claim that after five minutes' treatment in his machine a No. 7 surface would be improved to a No. 4; after ten minutes such a surface could with truth be designated a No. 2.

We have not discussed this subject of surface of castings with any of the leaders of thought in the industry, but its importance was brought forcibly before us when a salesman for a Black Country foundry claimed that his castings had the best skin of any make entering the London market. This he attributed to a combination of machine stripping and qualities of the sand used. His method of proof is visual inspection, but with years of satisfactory production as an industrial history, a type of atrophy may have been unconsciously developed.

To refer once more to the machine. An apparatus exists for the reproduction on medals and coins of designs and figures drawn to a very much larger scale. The machine we envisage is the inverse of this, and we feel that it is not asking too much of the engineer to provide such an instrument.

Once it is available, we suggest the B.C.I.R.A. should inaugurate a research, augmenting their normal source of funds by an appeal to those people whose very existence depends upon that illusionary quality—"finish of surface."

Foundry Queries.

Pipe Making in the Dominions.

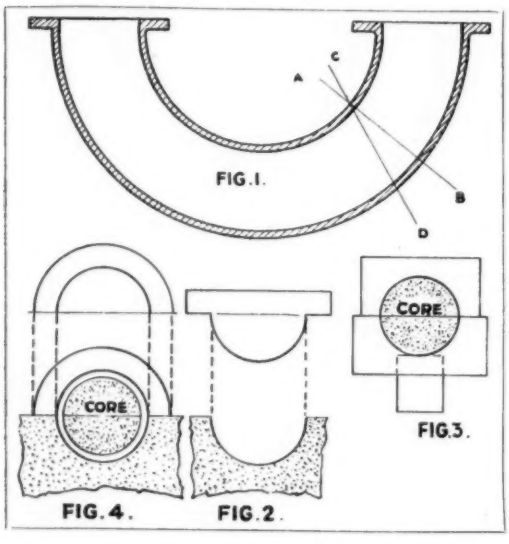
Your correspondent "Allan," in asking for information, while apparently giving a lengthy outline of his difficulties, leaves quite a lot of the detailed causes to be guessed at in his query. I presume, therefore, that the pipes referred to are (1) not straight lengths, but specials; (2) not made from good patterns, but possibly from skeleton patterns giving doubtful mould sections; and (3) made under difficult conditions and with inferior tackle, such as boxes and crane service.

The last two are representative of what one might expect in such a foundry as the one referred to, although they may, and actually do, prevail in foundries very much nearer home.

In the absence of details it may be assumed that a pipe is being made somewhat similar to the one shown in Fig. 1. There are, of course, several methods available, but two of these may be left out of consideration, and being in one case the use of a full pattern, and the other taking advantage of the pipe forming half a circle, thus making a fairly simple and safe loam job requiring only a few strickles and flanges.

Other methods include using a pattern formed from a core with extra material added to allow for metal thickness.

Secondly, by using a board with numerous laggings attached, this board following the outline of the pipe, while the laggings are rather



less than half of a circle equal to the outside diameter of the pipe, so that after they are fixed to the board, a cross section through two on opposite sides, and opposite each other, will be approximately circular.

Another method would be to provide a frame having an opening the shape of pipe, and either carrying a strickle guide laid along and parallel to one edge of the opening, or the frame itself on one side may be narrow and follow the outline of the inside, to serve for a strickle guide. In this manner a sand pattern for the top half could be strickled, the bottom portion of the mould being strickled out of the floor through the opening in the frame. Whatever the method we have got to assume there exists a mould having a horizontal joint level with the correct centres of the flanges, obtained by levelling these when commencing the mould. A quickly made gauge, as shown in Fig. 2, will indicate quickly, by trial at short intervals along the mould, whether the mould for the bottom half is correct to shape or otherwise.

A rough gauge in two halves, as shown in Fig. 3, can next be tried along the core, while core is supported on logs prior to placing in the mould, the joint of the two halves being kept horizontal all the time.

After setting the core in the bottom half of the mould a gauge, as shown in Fig. 4, and which may be a half-flange with an opening equal in diameter to that of the outside of pipe, may then be tried along the joint, and thus, by representing the exact position that the top box will occupy at different points, a guide to the thickness may be obtained. Each of the gauges referred to must be held at right angles to the direction of the pipe at each trial point, in the case of an arc or portion of a circle being, of course, held radially, as AB, not as CD.

Thus all thicknesses should now be assured.

The other difficulty, that of obtaining equal thickness in the top half, will depend on the matching or otherwise of the outline of the top and bottom joints. The gauge shown in Fig. 2 and used as in the bottom half will show whether there is sufficient mould space in the top. Where extensive repairs have been necessary in the top due to a bad lift the joint line may be uncertain, and with an irregular-shaped pipe it would be advisable to test this by placing along the outline of the pipe, at the ends and at short intervals all around, small squares of paper with spots of gum or moist clay on the top, so that when the top is tried on these will be picked up and thus show the outline of the bottom half in relation to the top half, enabling the latter to be pared or patched to conform to the bottom outline. The greater the number of such squares of paper the better, as some are liable to get moved out of place by a rush of air when closing the mould. It should be easy to recognise any such paper squares displaced, and these can then be ignored.

Such information as has been outlined is of necessity bound to take up much space, but the actual operations need take up little time, actually much less than they take to describe.

A cruder method, which may, however, be used in conjunction, though more applicable in the case of dry sand moulds, is to place "worms" of clay *across* the core at intervals reaching to the joint at each side, giving a rough idea of the thickness in the top half at several points.

Jobbing pipes, generally, are important castings, but more often than not are made from crude patterns. Urgency, coupled with the necessity for avoiding heavy expense for what may be only a "one off" job, often mean the use of inferior tackle, with sometimes indifferent results.

"ECOSSAIS."

Aluminium Silicon Alloys.

When manufacturing aluminium silicon alloys my greatest difficulty is in the elongation—my highest until now being 3 per cent., with a tensile of 11 tons. This is with an alloy containing 11 per cent. of silicon. I do not use the raw silicon, but a 50: 50 Al-Si alloy.

I melt the aluminium in a Salamander crucible, and immediately it is melted I introduce the Al-Si alloy, stirring well all the time. Immediately all lumps have disappeared the crucible is withdrawn from furnace, and about 2 oz. of zinc chloride is stirred in as a flux. The metal is poured at a temperature of 690 deg. C. I may add that test bars have been cast with and without the above flux, but the results have been about the same.

I should be glad if any of your readers, through your columns, could put me on the right lines so as to get a test bar of about 11 or 12 tons tensile and 6 to 8 per cent. elongation. W. S. C.

Sand Blast Plant.

We are contemplating putting in a sand-blast plant to cope with two to three tons per day of grey iron castings in two distinct classes—(1) From a few ounces to 56 lbs., and (2) from 56 lbs. to 5 to 7 cwt. Very few large castings, say more than 4 ft. square, are made. We should like readers' views as to cost per cwt. for each class, and the best method of carrying out such operations. Does the improved appearance of the casting carry with it enhanced prices. Obviously any details or experience will be appreciated. We should like to suggest sand blasting as a useful subject for a lecture at a branch meeting of the Institute. This would, if prominently noticed in THE FOUNDRY TRADE JOURNAL, attract considerable attention, as we know several people that are considering this problem.

"ENGINEER."

Some Experiences with Malleable Cast Iron.*

By H. Field (Metallurgist, Messrs. J. Harper & Sons, Willenhall).

The concern with which the author is associated having now ceased to make malleable cast iron, of which, incidentally, they were one of the oldest makers in the country, it has become possible and perhaps desirable to sum up the experience gained therein, and pass it on to those still interested in this trade before it shall have slipped from memory. The Paper is not intended to be a comprehensive guide to malleable founding and annealing, but simply includes notes on a number of interesting points which have arisen from time to time. As far as possible, practice rather than theory will be dealt with.

The pig-iron used for this work is necessarily hematite, since only such irons contain that low phosphorus-content of under 0.1 per cent. which is essential for the production of a malleable product. Attempts have been made to use other irons with higher phosphorus content, more especially when pig-iron was so scarce during the Great War, but it may be taken as impracticable to use iron with 0.2 per cent. phosphorus or over, whilst standard tests cannot be obtained except with less than 0.1 per cent.

Many of the irons offered for this purpose are termed "refined," but it has always been difficult to get information as to the nature and purpose of the refining process. Generally, it seems to consist of melting in a species of cupola, with high pressure blast, so that to a small extent the molten metal is Bessemerised and its carbon, manganese and silicon contents reduced. This was apparently the general practice in days prior to the present decade, but the author surmises—perhaps incorrectly—that of recent years there has been a tendency to produce the "steel" effect by the simple addition of steel scrap to the original hematite pig in the cupola. In any case experience suggests that better malleable castings can be made from "refined" irons than from the coarser grades.

The fractures chosen for this work extend from white to soft mottled, corresponding generally to a silicon content of 0.5 per cent. to 1.0 per cent. The requirements in this direction naturally vary between the Coventry motor trade and the Walsall saddlery trade, but hard mottled iron with 0.75 per cent. silicon will produce a very wide range of castings if annealed correctly.

For some years now there has been on the market an East Coast refined iron cast in chill moulds, and in the use of this brand mixing by fracture breaks down, for the small section of the pig has a wholly white fracture over a very wide range of silicon content. Pigs have been found in the same truck with silicon from 0.6 per cent. to 1.65 per cent., yet quite indistinguishable by a mere visual examination. Such iron is renedered white by chilling, and not by its analysis, hence after remelting, when the chill effect disappears and the analysis regains control, the resulting metal will have a totally different fracture and may even contain some primary graphite spots. In an experiment some of this iron containing 1.2 per cent. silicon was melted in a crucible and cast into a varied size of bars. At the same time a melt was made with a West Coast iron containing equal silicon but of a fracture so grey that the pig could easily be drilled. The fractures of the two sets of bars when placed side by side were indistinguishable whilst the analyses were also practically identical. The results of the experiment are shown in Table I.

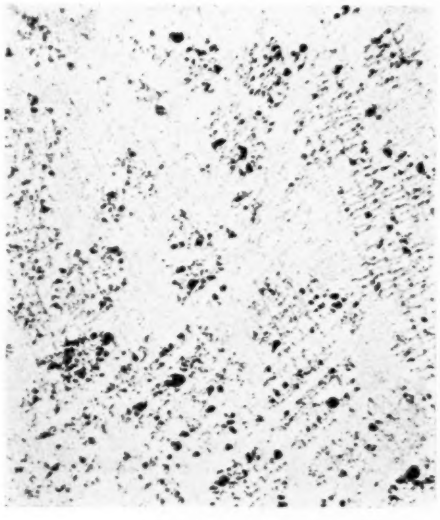


FIG. 1. × 50.

CLUMPS OF FREE GRAPHITE IN AN OTHERWISE WHITE IRON.

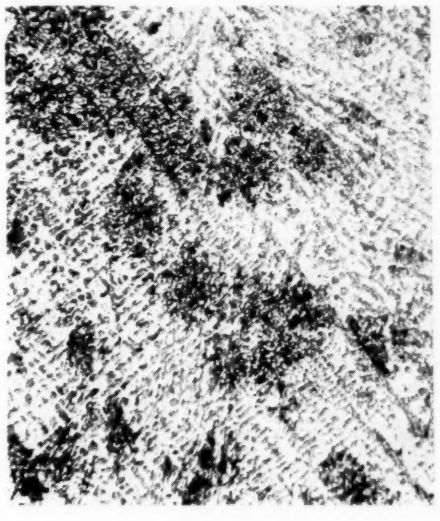


FIG. 2. × 50.

AS FIG. 1 ETCHED. SHOWING ALTERNATE PATCHES OF GREY IRON AND WHITE IRON.

The test bars from these melts were annealed along with other malleable work, and the results can be used to demonstrate the influence of primary graphite in malleable cast iron. There is no more powerful weakening influence in cast iron than large flakes of graphite, and when present in annealed malleable these flakes readily lead to breakdown. The 1 in × $\frac{3}{8}$ in. bars which before annealing had grey centres and white edges gave after annealing only 5 per cent. bend in each case, whilst the annealed $\frac{7}{8}$ in. bars when turned down for tensile tests broke at 11.2 tons and 12.0 tons respectively, without measurable elongation. Where this form of graphite is present there is no pearlite formed on annealing, and therefore a lower tensile results, and since the graphite breaks up the continuity of the metal this prevents any reasonable elongation of the ferrite matrix Such graphite spots generally occur near the centre of the casting, the outer portions remaining white, and as this white iron after heat treatment yields pearlite, there occurs the unusual phenomenon of

* A Paper read before the Birmingham, Coventry and West Midland Branch of the Institute of British Foundrymen, Mr. D. H. Wood presiding.

TABLE I.—*Chill Cast and Sand Cast Pig-Iron.*

Pig-Iron Used.	Sand Cast.	Chill Cast.
Fracture of pig	Grey.	White.
	Per cent.	Per cent.
Analysis of Pig-Iron : Si. ..	1.15	1.19
S. ..	0.22	0.20
P. ..	0.13	0.065
Mn. ..	0.32	0.28
T.C. ..	3.47	3.50
C.C. ..	1.0	3.50
Fracture of 1 in. sq. test bar	Grey.	Grey.
½ in. rd. test bar	Grey.	Grey.
1 in. × ½ in. test bar.. ..	Grey centre, White edges.	Grey centre, White edges.
	Per cent.	Per cent.
C. C. in 1 in. bar	1.20	1.20
Transverse test on bar 12 in.	Cwts.	Cwts.
× 1 in. × 1 in. ..	28.3	25.3
Deflection	0.120 in.	0.110 in.

fined irons, there are well-known brands of first quality such as Lorn charcoal iron, produced under conditions favourable to purity, but their price is too high to allow of universal adoption. Pig-iron of suitable quality for malleable work is also produced in the Midland district, and is establishing a reputation for itself.

Melting Conditions.

As a result of the comparative purity of these white pig-irons as compared with ordinary grey iron, the melting point is higher and the range of useful fluidity more restricted in malleable practice than in grey. Thus it is essential to melt at a higher temperature, which is accomplished partly by the use of higher coke ratio and partly by a lessened tuyere ratio—which latter results in an increase blast pressure. It may be taken as excellent melting practice if 1 cwt. of coke will melt 8 cwt. of iron exclusive of bed, and from 14 to 16 ozs. blast pressure is quite usual.

"Letting Down" Heavy Castings.

These pig-irons exhibit larger liquid and solid shrinkage than does grey iron. The increased

FIG. 3. × 50.

AFTER ANNEALING. LARGE PATCHES OF PRIMARY GRAPHITE STILL PERSISTING TOGETHER WITH SMALL DOTS OF SECONDARY GRAPHITE.

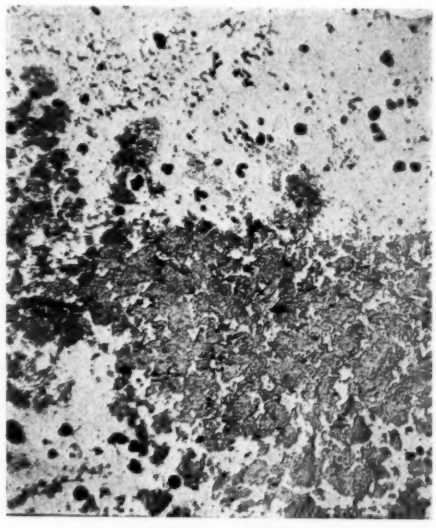


FIG. 4. × 50.

AS FIG. 3. SHOWING PEARLITIC NATURE OF EDGE OF METAL. THE LOWER PART IS THE EDGE, THE UPPER PART IS THE CONTINUATION OF THE LOWER HALF OF NO. 3.

the outside of the malleable casting being higher in combined carbon, and consequently harder, than the centre.

Figs. 1 to 6 illustrate these points.

It is essential that the pig-iron used should be as low as possible in sulphur. The malleable founder is fortunate in that he can produce good castings with iron much higher in sulphur than could be tolerated in any other branch of the iron or steel industry. Were it not so he would long since have been compelled to abandon cupola melting, for with the rather large proportion of coke required for melting, and the heavy percentage of scrap, produced by runners and feeders and necessarily included in the furnace charge, it is difficult to run a malleable foundry and consistently keep the cupola metal below 0.3 per cent. in sulphur. Some pigs on the market regularly contain 0.4 per cent. and the author has handled certain brands with as much as 0.85 per cent. sulphur, under which conditions it will be difficult to keep the cupola metal under 1.0 per cent. of sulphur.

Sources of Pig-Iron.

The chief centres for producing this pig-iron are the North-East and North-West Coasts, and it may be taken that the West Coast irons are generally characterised by higher manganese contents than the East Coast ones. In addition to the re-

liquid shrinkage necessitates the use of larger feeding heads and of chills, whilst the increased shrinkage after solidification renders it advisable to provide a "letting-down" muffle for all heavy or intricate castings, so that cracking may be avoided. Such a muffle is kept at about 600 to 700 deg. C. during casting time and allowed to cool down very slowly over night.

Some remarks have already been made upon the analysis of the melted metal. This depends to a large extent on the weight and section of casting under review. Under proper control much variation in analysis can be rectified in annealing, but even so the author found it impossible to produce malleable iron from pig with 1.8 per cent. silicon, when none other was available, as oxidation sets in as soon as annealing is commenced, and even after a short time in the oven sections ¼ in. thick contained oxide right to their centres. Such metal is shown in Fig. 7.

At another time during the scarcity of pig-iron the only supply of pig-iron showed 0.85 per cent. sulphur, resulting in a casting with over 1.0 per cent. sulphur, but after one or two failures this obstacle was successfully surmounted in annealing.

It is well known that manganese above 0.4 per cent. retards annealing as a result of the stability of manganese carbide. Some of the West Coast irons contain 0.5 to 0.6 per cent.

manganese, but the high sulphur in the cupola metal carries away so large a proportion of this percentage that the final amount in the melted metal is rarely over 0.25 per cent., which is not sufficient to retard annealing. In the manufacture of can-metal with over 1.0 per cent. manganese it is found necessary to use in the cupola charge about double the manganese desired in the melted metal. After a normal annealing this high-manganese metal gave 31.5 tons tensile, 10 deg. bend, and 8.0 per cent. elongation. Whereas ordinary malleable bars annealed in the same can gave 22.8 tons tensile, 75 deg. bend, and 11.1 per cent. elongation.

Size Limitations.

There are upwards limits of section which cannot be successfully malleablised. Heavy castings 4 or 5 in. thick can be repeatedly annealed so that the true malleablising penetrates for a distance of 1 in. or so and the whole casting is thus rendered exceedingly strong; but in the author's experience there always remains over 2 per cent. of carbon at any depth greater than 1½ in., and under these circumstances the interior metal, although soft to a drill, would, if cut into test-bar form, show only a very low extension and bend properties. Such castings find extensive use in engineering construction, but it should be clearly realised that for true malleable iron, to give 45 deg. bend or 5 per cent. elongation, a section of ¾ in. represents the practical maximum.

The difficulty most often encountered is not, however, the malleablisation of such heavy sections, but the successful annealing of the combined light and heavy sections which go to make up so many of the castings called for by engineers. Sudden changes in section from ⅛ in. to ¾ in. are encountered and are most difficult to deal with. If the buyer would expect from the heavier parts of such castings nothing more than machinability it would be possible to meet his requirements, but when ductility is demanded in every part of the casting the proposition is an exceedingly stiff one. Again, a heavy boss, perhaps 1½ in. in thickness, attached to an otherwise light casting, often renders at least double annealing time necessary, apart from the difficulty of uniform annealing already referred to. This hinders production, and thus arises one of the greatest handicaps from which malleable castings suffer, *i.e.*, time required for delivery after receipt of order. Every opportunity should be taken to lighten such bosses by using maximum-sized cores possible, for a ⅜ in. core often saves three days' annealing. In the author's experience all varieties of levers called for by different sections of engineers are great defaulters along these lines.

Whilst there is a modicum of truth in all the talk of co-operation between engineer and malleable foundry, the founder might also save much trouble for himself if he would seek a true realisation of the needs of the user of malleable iron. Speaking generally, there is a continual flow of castings back from the engineer to founder for re-annealing owing to hardness, and if the founder would set himself to ascertain the machining speeds used or desired by his customer and set up a simple machine to test his castings in this direction, there would be far fewer rejects than now obtain. Beyond the border line of obviously hard metal there are many degrees of annealing before a maximum toughness is reached, and the requirements of the user can be met if they are studied and allowed for in annealing. The author's firm, after being makers for many years, are now buyers of malleable castings, and thus he can speak for both sides of the industry.

It is not proposed to deal with the annealing oven design in this Paper. The old rectangular coal-fire oven, with grates running about three-quarters of the length down each side, is now much despised, but its one great advantage is its varying temperature from wicket to fire-hole, thus providing for the careful worker a means of dealing with a variety of sections in one oven. In such ovens there is no difficulty in annealing maximum and minimum sizes of castings in one anneal, for the temperature variation covers a range of 50 deg. C. more or less, and this compensates for the difference in section. In circular ovens more difficulty is encountered, and it is necessary to run separate heats for light and heavy work, a necessity which in a small concern often causes delay. In the rectangular ovens referred to the temperature in the hottest part of the oven should be maintained at 960 to 980 deg. C. for iron of generally suitable analysis. It is, of course, desirable to equip ovens with recording pyrometers, but where the cost is prohibitive very successful control can be maintained by recorders of the Watkins type or by Seger cones.

FIG. 5. × 100.

WHITE IRON. SILICON 0.69 PER CENT. SULPHUR 0.068 PER CENT.

FIG. 6. × 100.

WHITE IRON. SILICON 0.76 PER CENT. SULPHUR 0.345 PER CENT.

Jolt-Filling of Annealing Cans.

The production of good castings is in one sense largely dependent on the careful packing of the hard castings in the cans. With work of intricate shape and in hollow forms any careless filling will result in such badly distorted castings that correction in the dressing shop may be impracticable. In the States these cans are generally filled by jolt rams, and in a few simple tests the author found this an excellent method—provided

plant is available. Distorted castings are often strained during cold straightening, and were it not for the large margin of safety adopted by the designer, failures in such castings would result.

Types of Ore Used.

For successful annealing two distinct types of ore are necessary—old or used ore and new unused ore. The new ore is red hematite, and can be obtained in varying sizes, that known as 60 kibble being most suitable for ordinary work. The quality of this material from different mines varies considerably, and may also vary from the same mine. The only constituent of value is ferric or iron oxide, Fe_2O_3, and a good ore should contain from 80 to 90 per cent. of this, the remainder being principally silica in the form of

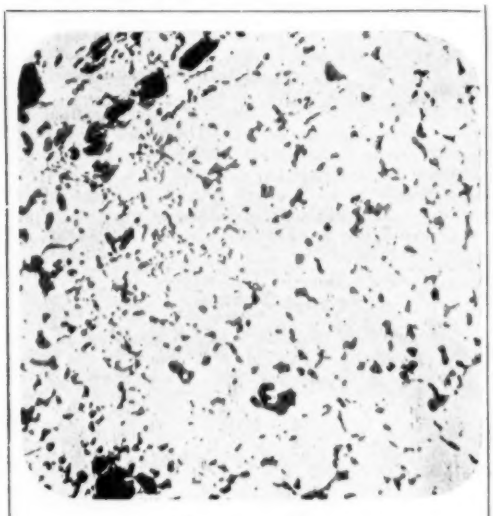


Fig. 7. × 50.

Iron with 1.8 per cent. Silicon. ¼-in. Section was very Badly Oxidised in Annealing. Dark Patches are all Oxide.

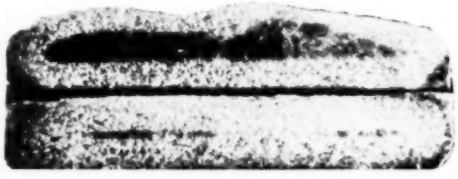


Fig. 8. Twice Full Size.

Fractures of Castings Annealed in Old Ore and New Ore. Polished and Etched. Centre Dark Portions are Hard Metal.

Upper.—New Ore. Lower.—Old Ore.

quartz. In poor ores abundant white pieces of this quartz are visible after washing, and if present in excessive quantity, will cause the ore to stick to castings. Lime, when present above 2 or 3 per cent., has the same effect but in a more marked degree, and in the author's experience ores with over 6 per cent. lime have given disastrous results. Table II gives details of some red hematite ores.

When heated in contact with iron, whether of the casting or the annealing can, red hematite ore blackens and changes almost entirely to Fe_3O_4, the magnetic oxide. This form of ore and oxide is essential for annealing, as apart from any question of cost, new ore alone will not do the work properly. When the red ore alone is used it so strongly oxidises that all carbon is rapidly removed from the outer layers of metal, and oxidation of the iron then commences so that a layer of scale is found on each casting. When removed, this leaves the casting rough and under size, and of course there is always more or less an oxidised layer remaining which is unsuited for either a machining or a finished surface. In such cases the removal of carbon from the surface is accomplished at a rate faster than it can be supplied by diffusion from the interior, and the net result is that complete annealing, *i.e.*, malleablising right to the centre, is often less rapid with all new ore than with standard mixture.

Table II.—*Annealing Ores.*

Description.	FeO	Fe_2O_3	Fe_3O_4	SiO_2	CaO
New ore. Good supply	—	90.7	—	4.7	0.85
Poor ore. Same supply	—	68.7	—	23.8	2.0
Poor ore. Same supply	—	63.7	—	30.3	1.95
Poor ores, all satisfactory in use..	0.6	70.0	—	19.4	3.8
	—	67.8	—	11.9	7.35
	Nil	74.1	—	7.9	8.3
	1.3	71.6	—	12.3	10.3
Used annealing ore	—	Nil	79.3	20.3	0.8

Fig. 8 illustrates such a case where similar castings were annealed under conditions alike in every way except strength of ore. The lower casting annealed in all old ore has a faint core of unannealed metal, while the upper one from all new ore is not more than half-annealed. The correct ore strength varies according to requirements, but four parts old ore and one part new ore is a good working standard. Annealing cannot be hastened by increasing the strength of the ore mixture much above this level or the castings will suffer.

From these considerations it becomes evident that not new ore only but also old ore must be regarded as one of the essential raw materials of the annealing process. With sudden increase of requirements there may be a shortage of old ore, and unless it can be acquired from a neighbouring foundry the shortage will be serious and costly. There is no ready method of converting red ore to black except by its use in annealing. It has been suggested that in such cases the old ore be replaced by scale from cans, but the author's experience has been that such a mixture is still strongly oxidising towards the skin of castings, although certainly less so than new ore alone. The use of turnings is more satisfactory, but these should be from steel, not high phosphoric cast iron, as in the latter case they will tend to fuse with the ore. There is, in fact, no cheap and simple method for this conversion, and the safest plan is to mix the new ore and turnings, or, better still, scrap unannealed castings and charge these into the cans in the usual way without any work for annealing. After a few days' firing a good stock of old ore is obtained without risk of spoiling an oven full of work. The conversion cannot be brought about by the simple application of heat to new ore, but contact with metallic iron is necessary.

(To be continued.)

The Works' Chemist.

At a meeting of the London Local Section of the Institute of Metals, held on Thursday, March 17, at the Society of Motor Manufacturers and Traders, Limited, Pall Mall, S.W.1, Mr. C. E. Barrs, F.I.C., read a Paper entitled "The Works' Chemist."

In the course of his remarks the lecturer pointed out that the works' chemist should obviously know something about the works and therefore should not be confined to the laboratory. He should take a lively interest in the manufacture of those products which he is testing day by day, because not only will he be able to make useful suggestions for better works' practice, but it will help him to understand better the relative importance of many of the daily tests he is called upon to make. Further, he should cultivate a friendly spirit with the workmen with whom he comes in contact and listen to their ideas, as an observant workman can frequently tell whether a material has worked well or not, and his opinion may prove very helpful to the chemist.

The author went on to describe the organisation of a laboratory, and his Paper, which was illustrated by lantern slides, was designed particularly to interest and help young chemists.

Practical Crucible Steel Melting.*

By J. F. Kayser.

In spite of the advent of the electric furnace, it is probable that at the present day the value of steel produced in crucible-steel furnaces is greater than ever. Years ago, only plain carbon steels and very low alloyed steels were known, and the difference between the price of steel for, say, rails and tools, was, comparatively speaking, small. That difference is now greater than ever before and, at the present time, steels whose market value in bar form is as high at £650 per ton are produced from the crucible furnace. In the author's opinion that fact is ample justification for the presentation of a Paper on the practical aspects of crucible-steel manufacture.

In this country crucible-steel furnaces fall into two main groups: (1) Coke fired; (2) producer-gas fired. The section of a modern crucible-steel furnace is almost identical with that of furnaces in operation fifty years ago. Probably the only difference is that the stack is higher and the holes deeper than formerly, and the lining is of crushed ganister, whereas long ago it was usual to line crucible-steel furnaces with road sweepings.

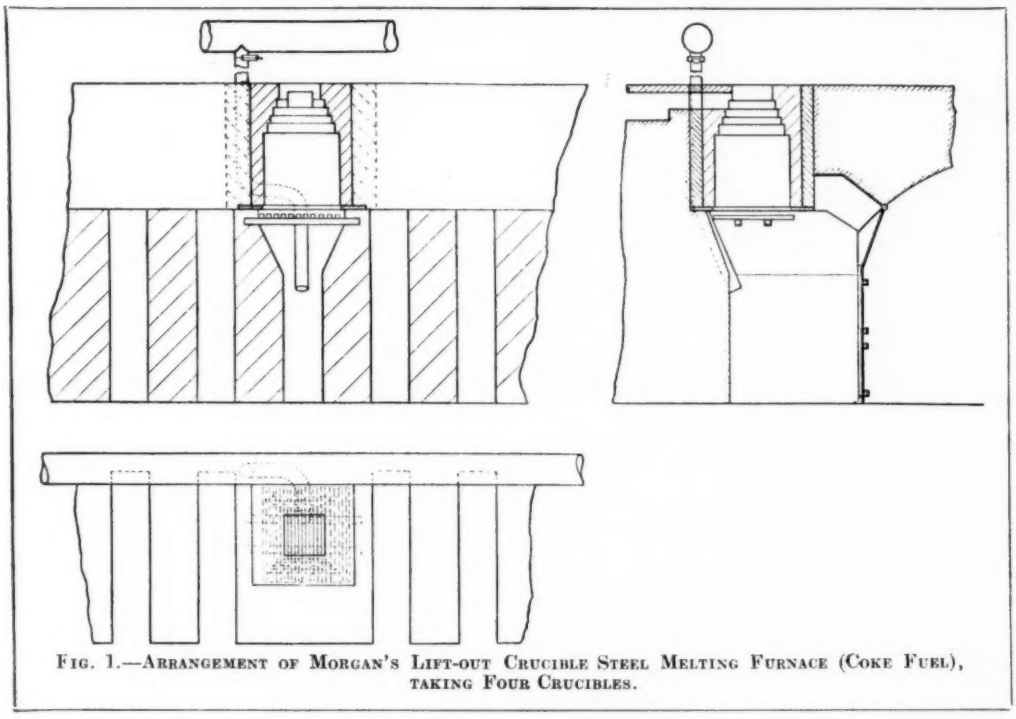


FIG. 1.—ARRANGEMENT OF MORGAN'S LIFT-OUT CRUCIBLE STEEL MELTING FURNACE (COKE FUEL), TAKING FOUR CRUCIBLES.

It is not generally known outside the ranks of furnacemen that it is possible, and indeed necessary, to accurately control the temperature of this type of furnace. The temperature is controlled by suitable manipulation of the cover which covers the hole, the bricks in the cellar flue, and the size of the main flue into the stack. The furnace lining and main flue are built by the furnacemen, and the dimensions of the flue and the position of the furnace opening relative to the central axis of the furnace chamber influence the characteristics of each particular hole. Consequently, in a furnace consisting of twelve holes, one six usually differ somewhat in their behaviour from the other six, due to the fact of one furnaceman controlling the final building of one lot and another furnaceman controlling the building of the other. Roughly speaking, if the main flue is relatively broad and shallow compared with the depth of the hole, there will be a tendency for a high bottom heat, whereas if the main flue is relatively deep the hole will have a tendency to develop a high top heat. It is difficult to say which is preferable. For quick melting, the former is undoubtedly preferable, but quick melting goes hand in hand with runners, as will be mentioned later. When the furnace develops only top heat, the pots are not so likely to run, but, on the other hand, the charge will be unduly long in the furnace, and if it be very mild or contain high-melting-point alloys, it may not be possible to melt it at all.

The temperature of the hole can be regulated in any one of three ways, either separately or in conjunction with one another. The quickest way of causing a reduction in temperature is to turn off the cover slightly. If that is not sufficient, a brick may be inserted in the main flue, or the bricks in the cellar flue may be slightly twisted or, in extreme cases, removed altogether. If the front pot shows a tendency to melt more quickly than the back, it may be checked by the introduction of a brick into the main flue, whereas if the back pot is the quicker melter it is usually checked by the manipulation of the bricks in the cellar flue. Besides having bricks in the cellar flue, it is customary to place a sheet of paper over them to further improve the draft, and the first step in damping the holes usually consists in removing the papers. It might be mentioned here that the draft created by the stack is sufficient to hold a sheet of thick brown paper, firmly in contact with the bricks.

The thermal efficiency of a crucible furnace, as described above, is very low and, whilst it varies with the type of steel being melted, the coke and pots used, etc., it can be taken as being in the region of 1½ to 2 per cent. For some few years furnaces of a design similar to the above, but large enough for the reception of four crucibles, have been used to a limited extent. It is, however, difficult to work four pots together in one furnace unless easily-melting steels are being made, as it is almost impossible to keep the pots away from each other and prevent a cold centre in the furnace. The advent of plumbago crucibles, detailed reference to which will be made later, has, however, rendered a furnace of that type possible, and Fig. 1 illustrates the furnace developed by the Morgan Crucible Company of Battersea. It will be noted that this furnace is suitable for building on to the ordinary Sheffield stack, and that it works with a closed ash-pit and forced draft. With a furnace of this type the thermal efficiency may on occasion be as high as approximately 3 to 3½ per cent.

* Paper read, February 22, before the Sheffield Metallurgical Association.

The most economical crucible furnaces are fired with producer gas. Descriptions of producer gas-fired furnaces can be found in many text books, and the arrangement of ports, sizes of generators, etc., have been so thoroughly dealt with in numerous publications to learned societies, that it is not proposed to give any detailed description of a gas-fired crucible-steel-melting furnace. The thermal efficiency can usually be taken as being about 4 per cent.

The crucibles in which steel is melted are usually large enough to hold approximately 120 to 130 lbs. of steel when filled to the brim, but the weight of a charge is usually about 60 lbs. On occasion it may be as a high as 70 to 75 lbs., but that is not the usual practice. Clay pots are made from a suitable mixture of fireclays, to which approximately 5 per cent. of coke dust is added. In the author's opinion, pot-making calls for greater skill than any other operation in a crucible-steel works. The various clays are mixed together in the dry state and sieved, and are then brought to the consistency of fresh putty by being mixed together with a suitable quantity of water. In one, or perhaps two, Sheffield works that operation is done mechanically, but the author has found, as a result of a considerable amount of experience, that it is far better to knead and mix the clay by treading it with the bare feet. It is not that the actual mixing is better or more uniform, but that by so treading it the potmakers, as a result of years of experience, can tell by the feel how the clay is working, and it has often been observed that, during the treading process, several further additions of one clay or another may be made according to requirements. It is quite wrong to suppose that the potmakers of this country refuse to divulge their mixtures. All the potmakers with whom the author has come in contact have been only too ready to give all possible details, but they always explain that clay varies greatly, even if it comes from the same bed, and that sometimes they find it necessary to use more of one clay than another and *vice versa*.

The finished clay crucibles weigh from 25 to 40 lbs. each. If they are made throughout by hand there is a hole through the bottom. If a machine-driven plug and flask are used it is, however, not necessary to have a hole through the bottom, which is then usually about ½ in. to 1 in. thick. As soon as clay pots have been removed from the flask, they are placed in a warm position and should be allowed to dry for at least four weeks. It is then necessary to heat them slowly to a temperature of approximately 800 deg. C. That operation normally takes 20 hours, but at the end of the week, when the last shift usually starts work at Friday midnight, it is customary to anneal the pots in approximately twelve hours. When the pots have been annealed, they are removed from the furnace or grate and placed on stands in the hole which has already received a charge of burning coal. They are surrounded by cokes up to the lid, and the temperature allowed to rise to approximately 1,100 deg. C., when the bottom is made good with sand. The sanding operation should always be carried out carefully. It is usual to use half Calais sand and half red sand. If that does not frit sufficiently readily, the proportion of Calais sand may be lessened, whereas if it frits too easily and has a tendency to "come up," it is advisable to increase the proportion of Calais sand or to introduce a little powdered ganister.

During the last five or six years plumbago crucibles have been adopted to a certain extent for the manufacture of most types of crucible steel. The only disadvantage of a plumbago crucible is that it may give up an unknown and varying amount of carbon to the charge. Against that is the fact that on account of its high heat conductivity it is possible to melt three heats in the time normally taken for two, and the number of runners is very much less. The manufacturers of plumbago crucibles have carried out a great deal of research work and, as a result, can now supply a crucible which gives very little carbon to the charge if the latter is suitable, and what carbon they do give up they give up uniformly.

A plumbago pot suitable for the Sheffield crucible steel trade costs approximately 15s., and can be used for at least twelve and in many cases for sixteen heats. When melting in a four-pot furnace, as illustrated in Fig. 1, it is possible to melt with a coke consumption of approximately 1¼ to 1½ tons per ton of steel melted, whilst if a two-pot hole is used, the coke consumption will be approximately 1¾ to 2 tons per ton of steel melted. This saving in coke is rendered possible by the much higher conductivity of the plumbago pots and, to a lesser extent, to the fact that the ash of ordinary crucible steel-melting coke does not adhere to the bottoms of the pots, but rather washes them very slowly away, so that the pot becomes gradually thinner and does not form a "root" like a clay pot. The manufacturers also produce a pot with a non-carbonaceous lining, which can be used for the manufacture of all types of steel as long as the charge is very low in manganese or any alkali that may flux the pot. Melting procedure with plumbago pots varies greatly. In any event, it is not necessary to sand the pots, and they are of course nearly as strong at room temperatures as they are at full melting heat. In the case of a clay pot, the converse holds good. When cold, clay pots are extremely fragile, but when at melting heat they are so strong and tough that it is almost impossible to break them, even with a heavy pointed iron bar.

Ingredients for Crucible Steel.

It is important that the ingredients used for the manufacture of crucible steel should be of a suitable size, and the use of very light material, such as turnings or thin sheet steel, or of heavy steel, is not advisable except in small quantities. Light material is objectionable, as it requires so many steelings before a reasonable weight can be got into the pot, whilst very heavy scrap, etc., has a tendency to burst the pot, either by the violence with which it is steeled or by becoming wedged across and bursting open the pot when it heats up and expands. Certain types of material have also a tendency to settle in a very solid mass in the pot and to expand and burst the pots, and it is advisable to open up such material by the judicious admixture of a certain amount of light sheet or similar metal.

Whenever possible it is advisable so to choose the ingredients that it is unnecessary to use white iron or charcoal as a carbonising agent. Frequently, however, it is necessary to use one or the other, and, in the author's opinion, white iron should in every case be used in preference to charcoal. When charcoal is used, one usually assumes that 50 per cent. of the amount added will go into the steel, but it is quite impossible to work to close limits. In the first place, charcoal absorbs moisture very readily, and a change in the atmospheric conditions may easily give rise to a given volume of charcoal losing or gaining weight to the extent of 30 per cent., and so if charcoal is used it should be used by volume and not by weight. If the charcoal is in a very fine state of division a varying amount may be burnt away before it has time to be absorbed by the charge, whereas if it is in large pieces it decrepitates violently, and a considerable amount will fly out of the pot before the lid can be put on. White iron suffers from none of those disadvantages, and if it is first sorted by fracture, carbons can be controlled to within plus or minus 0.02 per cent. without difficulty; the author has worked for weeks on end with carbon variations between 0.64 and 0.68. In fact, very large quantities of high-speed steel are frequently produced in Sheffield in which the carbon content falls to within 0.03 per cent. Some brands of white iron are quite uniform, but it is advisable to break each pig and, if there is any difference in fracture, to sort them roughly into three grades, one white and "staring," another inclined to mottle in the centre, and the third with an intermediate fracture. If those three varieties are then analysed a very considerable difference in carbon will be found. For calculation purposes, however, the actual carbon determined by analysis can be assumed as being definitely available for carbonising purposes.

There is a difference of opinion amongst furnacemen as to when white iron should be steeled. One school hold that it should be placed low down in the first charge, so that it will melt early and form a bath for the remainder of the charge. The other school are of the opinion that such a procedure leads to runners, as the white iron will melt and may find its way through the

sand or may even wash the pot. The contention of the latter school is perfectly sound when spiegel is used, but there are no grounds for that contention when using ordinary white iron low in manganese. The author believes in always adding it well up in the shoulder of the pot, and thinks that it is advisable to put it in at the first steeling if two steelings are necessary.

The use of the above material with a high manganese content has a great tendency to wash the pot badly and give rise to flux holes, the action being more marked the longer the charge is retained in a molten condition.

When plumbago pots are used a high manganese content is not permissible if control of the carbon is necessary, as the slag formed has a great affinity for plumbago pots, the carbon of which will then pass rapidly into the molten charge.

The melting process can be said to commence with the steeling of the pots, and that is an operation which should always be conducted with great care. The mix shop should always be instructed to place the different ingredients in the weigh pans in such a way that the furnacemen can easily see what is present, and chockers should always be placed right in front and white iron and large lumps of metal on the top of the charge in one or other of the back corners.

The firing of the furnace is under the control of the puller-out, and is, in fact, the puller-out's main duty. The ability of a puller-out can usually be very accurately gauged by the number of runners and by the position of the pots in the hole. A capable man will have few runners, and it will be found that his pots are always standing upright with a reasonable amount of fire in between them. That remark particularly applies to holes taking four pots. Some furnacemen make a practice of placing one very large coke between the four, but that, in practically every case, causes a cold centre to the furnace, and the best practice is to fill up the centre with very small cokes. If there are no runners, the total loss on melting should not exceed approximately 1 lb. per pot, but if runners are of frequent occurrence the losses may be much more severe. As soon as the charge is overhead, that is to say, as soon as a liquid bath has formed, a constant watch should be kept in the cellar, and at the first indication of a runner the furnaceman must be advised which hole is running, and which pot, and whereabouts the leak is taking place.

(To be continued.)

American Foundrymen's Association Nominates Officers.

The Nominating Committee of the American Foundrymen's Association has recommended that Mr. S. W. Utley, Vice-President and General Manager, Detroit Steel Casting Company, Detroit, Mich., be asked to serve as President for a further period of one year. He is to have Mr. S. T. Johnston, Vice-President, S. Obermayer Company, Chicago, Ill., as his Vice-President.

It was decided to ask the following gentlemen to serve as Directors for three years:—Messrs. E. H. Ballard, General Superintendent, General Electric Company, West Lynn, Mass.; H. Y. Carson, Research Engineer, American Cast Iron Pipe Company, Birmingham, Ala.; W. D. Goldsmith, Treasurer, C. A. Goldsmith Company, Newark, N.J.; A. E. Hageboeck, Secretary-Treasurer, Frank Foundries Corporation, Moline, Ill.; and W. J. Nugent, President, Nugent Steel Castings Company, Chicago, Ill.

Not for Sale.

Amongst the small advertisements in our issue of November 4, 1926, it was announced that the owners of British Patents Numbers 191875 and 192677, both dated November 1, 1921, were desirous to enter into an arrangement for their exploitation in Great Britain. These patents relate to what is generally known as the Simpson intensified sand mixer, and the appearance of the advertisement was due to some misunderstanding on the part of the patent attorneys or agents, as the machine for a considerable time has been and still is being manufactured by Messrs. Augusts Muffle Furnaces, Limited, of Halifax, the well-known foundry engineers.

Research and the Metal Industries.

An exhibition which has been arranged and opened to the public at the Science Museum, South Kensington, affords some indication of the assistance given to British metal industries by the research and auxiliary services of an industrial research organisation.

The exhibit is that of the British Non-Ferrous Metals Research Association, which, with the co-operation of the industry through membership of the Association, carries on a two-fold service, firstly in the prosecution of research work either of a fundamental and scientific character or of direct practical utility, and secondly, in maintaining a highly-organised information service which operates for the general benefit of the Association as a whole and to meet the specific needs of individual member firms.

The present exhibit is concerned chiefly with eight of the Association's researches, chosen from among eighteen major investigations at present in progress. Those selected are typical of the character and wide range of the work which is being carried out, and the exhibits have been set out to give some idea of the scope of each piece of work and the progress which has so far been made.

Some indication of the range of work can be gathered from the subjects chosen for exhibition, which are as follows:—"Effect of Impurities up to 1 per cent. on the Properties of Copper"; "Gases in Copper Castings"; "Brass Casting: The Surface and Internal Soundness of Ingots"; "The Jointing of Metals"; "Die-Casting Alloys:—Section I, Brass and Bronze Alloys, Section II, Aluminium Alloys"; "'Wiped' Plumbers' Joints"; "Spectroscopic Assay of Zinc"; and "Atmospheric Corrosion."

There is also shown one case which gives information in regard to the Association's administrative, library and information services, with some examples of the work normally carried out in these departments.

The exhibition is open to the public daily, and literature descriptive of the material on view and of the other work being carried out by the Association may be obtained at the Science Museum or from the Secretary, B.N.F.M.R.A., 71, Temple Row, Birmingham.

Catalogues Received.

Pig-iron.—Messrs. Bessler, Waechter & Company, Limited, of Salisbury House, Finsbury Circus, London, E.C.2, have sent us two pamphlets dealing with the products of the Royal Dutch blast-furnace plant at Ymuiden.

The first one describes in a very interesting manner the locality of the plant, its position with reference to raw materials and export, the type of furnaces installed, their output and method of working.

This is followed by the analyses of the various grades manufactured, whilst in many cases they are accompanied by illustrations of the fracture. In this case we are not at all sure that the best tint of paper has been used to illustrate pig-iron fractures, and a "creamier" paper would have been better.

The second booklet deals with special low-carbon pig-iron—"Lowcar" brand—which is manufactured at Utrecht (Holland). Its tensile strength is stated to be 16 to 19 tons per sq. in., whilst the "resistance" is given as 35 to 38 tons per sq. in. This probably means the transverse test on 30 mm. dia. bar supported at 600 mm. centres. Again, analyses and fractures are given and illustrated.

Steel Castings.—Two well-produced catalogues have been sent us by Messrs. Kryn & Lahy Metal Works, Limited, of Letchworth, Herts. The first, an eight-page brochure, indicates to engineers the facilities the firm possesses for machining the castings they make or even taking the job a stage further and providing assembled units. The second, a four-page pamphlet, makes its appeal by outlining the range of their capacity, the scientific control exercised, the equipment utilised, and the service they give. An imposing list of satisfied clients makes it a creditable and telling piece of publicity.

XUM

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Foundry Pig-Irons—Necessity for Research.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—From the condensed report in your issue of this week it is very gratifying to me to see such an eminent American authority as my friend Dr. Richard Moldenke emphatically expressing his honest conviction that the ordinary analysis of cast iron does not tell the whole story by any means. It takes a strong man to have the courage of his convictions, and to make this statement after such a long advocacy of analysis.

The original international discussion goes back to the year 1909, perhaps earlier. In the spring of that year my friend, the late Herr Sulzer-Grossman, of Winterthur, showed me the details of a Paper to be presented at the Copenhagen Congress of the I.T.A., in the autumn of that year by their foundry manager, the late Herr Meyer. At this autumn meeting of the I.T.A., America and Germany carried a proposal to ask Great Britain to change her method of grading from fracture to analysis. This was considered by a thoroughly representative British committee, called together by Mr. G. C. Lloyd, the British secretary of the I.T.A., and the proposal was turned down, the late Mr. T. C. Hutchinson, the late Mr. Herbert Pilkington, and myself being three of the chief opponents, not because we were afraid to sell foundry pig-iron to analysis, but because it was not only considered premature but also against the best interests of the foundry industry. That was clearly stated at the time and has since been proved to be justified by the number of British and, during the last few years, American converts.

At the next Congress of the I.T.A. in New York in 1912 the subject was again under discussion, and it was admitted that the attitude I had taken up—and at that meeting confirmed—was justified. Since then much larger daily outputs are being obtained from the blast furnace, chiefly in America where, as Dr. Moldenke states, it is now realised that this is to the detriment of the quality of pig-iron produced.

This is not, however, because of the new impurities introduced into the iron as a result of driving the furnace harder—as Dr. Moldenke appears to realise when he refers to charcoal iron—but it is from other causes which, even if they were known, it would probably not be possible to correct in the working of the blast furnace if the output had to be maintained.

The experienced and observant blast furnace man knows the capabilities of his furnace, which he charges and works accordingly, but however carefully the furnace is burdened there is no absolute control of its product, whether this be 500 or 5,000 tons per week, therefore all grading and selection of pig-irons must be within the limits of what it is possible to obtain from the furnace, whether by fracture, analysis, or both. At the same time, after the iron is received from the furnace if the demand is sufficiently large the ironfounder can obtain anything he wishes within reason, providing, as Dr. Moldenke states, he is willing to pay the price.

With regard to so-called complete analyses, it has been suggested from Japan that there are several silicides of iron, but how is it possible to prove these by analyses? The fracture itself suggests this possibility in the higher grades of high silicon irons, and in these irons it is remarkable how one fracture tapers off into another of totally different character, not only in the appearance of the fracture but in the actual test results obtained.

Dr. Moldenke refers to catalytic action, but this alone would make impossible any reliable analyses of small percentages of "other foreign elements," for it is impossible to prove the presence of any unstable chemical compound, particularly an oxide, owing to the very effect of catalytic action.

After giving very careful consideration to the question for many years it is my considered opinion that improvements in foundry practice will not come from attempts to analyse for unstable chemical compounds, as yet unproved, due to modern conditions of manufacture. By making use of the already great and valuable experience of the practical blast furnace man, however, and by attempting to correct by secondary methods the deterioration of quality of iron due to modern conditions, it will be possible to make real progress.

That this can be done has already been proved, and it can be carried out on a large scale if necessary. Although it might add a little to the initial cost of the pig iron, it would effect a reduction in *final* cost of castings, which should be the true aim of the ironfounder.

It is becoming more and more apparent that the greater the rapidity of producing pig-iron or steel the greater in number and the more complex are the problems which have to be faced.

Yours, etc.,

E. ADAMSON.

18, York Street, Sheffield.
March 19, 1927.

American Foundry Practice.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Referring to Mr. Jolley's article, on page 106 of the February 3, 1927, issue, he states that the castings made with our process are white as they come from the moulding machine. This is not correct, they are grey, having a Brinell hardness of about 190.

In order to meet the machine-shop requirements they are heat treated to bring this down below 150. Of course, if the casting is made in a cold mould, that is to say before the mould has heated up to its working temperature, white spots are produced, but in the ordinary operation of our process the castings produced are normally grey.

The interesting point about the heat-treatment we give the castings, is that the impact test is thereby doubled. As the castings come from the moulding machine the impact strength is no more than that of the same iron when cast in sand. With the heat treatment we give, 15 minutes at 855 deg. C., brings out the real improvement in the quality of these castings.—Yours, etc.,

HOLLEY CARBURETOR COMPANY,
p.p. S. M. UDALE, A.M.INST.C.E.

Vancouver Avenue and P.M.R.R.,
Detroit, Michigan.
March 7, 1927.

The Carsil Process.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The data you give on the above process in your current issue are very interesting and speak abundantly of the patience and optimism of Mr. Carlisle. It is only by such courageous experiments that the truth can be obtained on the hardy annual promises of "steel direct from ore" enthusiasts.

Assuming, and one should expect seemingly favourable results thereby, the estimated costs given by the Anglo-American Steel Company for the process to be about correct, the cost of the raw separated sand ore per ton of iron obtained is just about equivalent to that of a ton of clean heavy steel turnings. The current used per ton of steel produced is five times: the electrode consumption is four times; and the output of steel from the plant is one-sixth that obtained when using heavy clean turnings. Naturally, better results could be obtained on the Carsil process from special plant: but even if the current and electrode costs and the time occupied were brought down to half of what is suggested, the steel produced would still be of no commercial value as compared with normally produced material.

The *bête noire* of all steel-direct-from-ore processes is the accompanying slag. A blast furnace in producing pig-iron uses at most one quarter of the fuel provided in reducing and heating the iron produced. It would seem that the Carsil process uses about the same proportion: but, as the balance, in the former case, is coke and, in the latter, electricity, there can be no competition from the electrical process.

We do not think that the cost given for comparison for making, in a 15 cwt. electric furnace, steel (presumably straight carbon) from scrap metal, viz £19 to £21, should be taken seriously. The cost in a modern furnace is below half this, including interest and depreciation.—Yours, etc.,

THE STOBIE STEEL COMPANY,
p.p. M. R. COMPSTON.

Dunston-on-Tyne. March 17, 1927.

Semi-Steel.*

By J. E. Hurst.

(*Continued from page* 232.)

Industrial Semi-Steel.

From personal experience of the industrial product semi-steel produced from various foundries in different parts of the country, it is found that they can be divided broadly into two classes, according to whether the total-carbon content has been reduced or not. The latter type in which the carbon content practically remains unaffected is by far the most common, and until the last year or two the low total-carbon variety of semi-steel was rarely if ever encountered amongst the industrial examples of the product.

The question of interest to engineers and foundrymen is the extent of the influence of the added steel on the properties of the resulting mixture. If attention is confined to the variety of semi-steel in which the total-carbon content is practically unaffected by the steel added the reduction in silicon and phosphorus contents would be expected to be accompanied by an increase in the strength properties. The most satisfactory figures published during recent years are the investigations of Wheeler. As a result of his investigations, Wheeler came to the conclusion that the quantitative effect of steel added in quantities of from 10 to 30 per cent. to a soft cast iron was an increase of 1 ton per sq. in. tensile strength for each 5 per cent. of steel added.

Whilst this improvement results from the addition of steel, it must not be lost sight of that the improvement is essentially due to the cumulative effect of the reduction in silicon and phosphorus contents. Any other method of bringing about a similar reduction in composition will be accompanied by a similar result. For example, the use of low-silicon hematite white iron in place of steel and in proportionate quantities is accompanied by similar results which confirms the fact that the improvements are not the intrinsic result of the added steel.

The question of distinguishing between the intrinsic influence of steel and the influence due to the modification in the composition induced by the added steel is one which constantly arises in these considerations. It arises again in connection with the size and distribution of the graphite. It is the general experience that the graphite structure in semi-steel mixtures is of a fine nature, and it is often stated that the addition of steel results in a finer graphite structure, but *finer than what?* This question is never answered. Is the graphite structure of a semi-steel finer than that of the identical composition produced by some method other than the addition of steel and cast under identical conditions of casting temperature and rate of cooling? The demonstration of this has never been carried out, and is, of course, a demonstration of exceptional difficulty.

For many reasons, however, the author is of the opinion that there would be no practical difference found in the graphite-size arrangement and distribution, if such a comparison could be effected. The fine graphite arrangement referred to in connection with semi-steels is undoubtedly a comparison with material of a different composition, and is due to the influence of the steel in the reduction of the silicon and phosphorus contents, not to any intrinsic influence of the added steel. Finally, it should always be remembered that the size and arrangement of the graphite structure is greatly influenced by the casting temperature and rate of cooling to which the metal is subjected. Even in semi-steels, poor graphite structures can be obtained under bad conditions of casting temperature and rate of cooling.

Low Total-Carbon Semi-Steels.

The first of the two divisions of industrial semi-steels is not nearly so often encountered in practice. When they are obtained it is generally agreed that they are accompanied by improved mechanical properties. Tensile strength of upwards of 20 tons per sq. in., even 26 tons per sq. in., have been recorded on low total-carbon content irons.

The conditions under which really low total-carbon content semi-steels can be produced with systematic regularity are by no means clearly understood yet. It is wrong that individual foundrymen should deceive themselves that this is the case. That such low total-carbon content irons can be produced from the cupola has been demonstrated on many occasions, but one constantly encounters many examples in which the very low carbon contents fail to materialise in spite of many precautions, some of which have already been enumerated.

In examining the possible causes of the variations in carbon content experienced, the author's attention has been directed to the possible influence of different varieties of coke on the results. The variations in the character of coke are now tending to be more clearly understood, and this aspect of the subject still awaits careful investigation in connection with the production of low total-carbon content irons.

The "Emmel" process consists essentially of the production of semi-steel. From his British Patent No. 244,405, one gathers that Emmel uses large quantities of steel from 50 per cent. of the charge upwards. It is stated that the low total-carbon contents are to be secured principally by regulating the amount of the blast or blast pressure. Blast pressures of 16 in. of water are quoted in the examples, and it must be confessed that these do not strike one as being very greatly different from those used in ordinary practice. Details of the quantity of air used are not given, and the coke charges given are 12 per cent. of the iron charged.

In view of other experiments, it is very doubtful whether these details constitute the whole story of the reduction in carbon contents obtained, and it might possibly be that the variety and character of the coke play an important part.

Semi-Steel Practice.

The American criticism referred to in the earlier part of these notes casts doubt on the ability of all but few foundrymen to make 25 to 30 per cent. semi-steel unless they have been instructed by an expert. It is of some interest to discuss the possible difficulties.

The difficulties which confront those who are desirous of producing semi-steel of very low total-carbon content have already been fully considered, and these difficulties are admittedly of such a nature as not to have been yet completely solved by experts.

What other difficulties are likely to be encountered? The answer is that there are few that are not fairly well understood by the majority of foundrymen. The general conversation of foundrymen when discussing this aspect of semi-steel manufacture generally centres round (*a*) the character of the steel additions; (*b*) the uniformity of composition of the final melt, and (*c*) the soundness and regularity of the final castings.

The Character of the Steel Additions.

Quite a wide variety of opinions have been expressed on the character of the steel scrap additions. Amongst these varieties of steel which have been strictly forbidden by various writers are:—(1) Borings, turnings and sheet cuttings; (2) punchings, and (3) high-carbon steels.

Speaking personally, the author sees no substantial reason why these varieties of steel scrap should be forbidden, with the exception of finely divided borings as distinct from turnings. Turnings are, of course, awkward in handling owing to the large bulk for a given weight, and are certainly to be preferred in a bundled or baled condition. He has used turnings consistently, and some of the results quoted above are obtained with their use.

* A Paper read before the Wales and Monmouthshire Branch of the Institute of British Foundrymen.

Uniformity of Composition.

There is no doubt that in melting two materials so dissimilar in chemical composition it is difficult to ensure regularity and consistency in the chemical composition. This difficulty was met in the earlier days by remelting the steel and iron mixture. This practice is not nearly so common, and undoubtedly the best way of ensuring regularity is either the use of a forehearth or mixer or to make arrangements for each individual charge to be tapped into one ladle.

Soundness and Regularity of the Final Castings.

The reduction in silicon contents resulting from the addition of steel results in an increase in the shrinkage value and the reduction in phosphorous contents is accompanied by a loss in fluidity which both have the tendency to increase the risk due to unsoundness. Provision requires to be made for this in the size and disposition of the heads, gates and runners, and also in the provision of sufficiently hot metal.

The presence of irregularities in the castings in the shape of hard spots has often been commented upon, and this is still regarded by many foundrymen as being due to the presence of particles of unmelted steel which have been carried along into the casting. This view, however, can be definitely ruled out as fallacious. One has only to consider for a moment how rapidly a steel stirring rod or skimmer melts and absorbs carbon when immersed in liquid cast iron to realise how unlikely it is that small particles of steel can survive as such in liquid iron, after flowing down the cupola spout, agitation in the ladle, agitation during pouring and flowing down the various "gates" into the casting. If such particles had any reasonable size they would hardly pass the cupola tap hole and through many of the gates used on various castings. The author has certainly never seen a hard spot in semi-steel castings which could be ascribed to this cause. Ordinary castings, particularly low silicon irons, are equally as much liable to the presence of hard spots as are semi-steel.

These points have been dealt with very briefly, as they have been ably covered by various writers recently, particularly by Mr. H. Field. None of these points presents any more serious difficulties than are normally met with in everyday cupola practice, and it is not thought that the average foundryman utilising his normal cupola experience needs the guidance of experts in making 25 to 30 per cent. semi-steel.

In concluding these notes it is thought essential to emphasise the fact that semi-steel is a cast iron possessing all the distinguishing properties of cast iron. Whatever better properties than common foundry irons it possesses are due to the effect of the steel in modifying the final composition of the melt. As in the case of general cast iron practice, semi-steel can be made of varying silicon, manganese and phosphorous contents, and the resulting properties will vary in accordance with the composition in an exactly similar manner to general castings. It is still necessary to add, for the benefit of many engineers who use castings, that none of the essential properties of steel, viz., malleability and ductility, is possessed by semi-steel intrinsically as a result of the steel additions. For the benefit of the average foundryman it may be permitted to repeat that semi-steel offers a delightfully simple and cheap method of obtaining a low-silicon, low-phosphorous iron—a good iron.

DISCUSSION.

MR. HIRD thought many engineers believed that semi-steel was something quite unique, and agreed with the lecturer that hard spots did not come from the steel additions. A few months ago he cast some test bars, which, when broken, showed a peculiar fracture. Running through the test-bar was a hard patch of white iron surrounded by grey. This was submitted to Mr. Pearce, of the B.C.I.R.A., who reported the patches were entirely due to sulphur. The test-bar was 2 in. × 1 in., 3 ft. long and cast on the flat, and when remelted there were no hard spots. The casting was made of pig-iron and scrap mixture.

MR. MCCLELLAND, after ascertaining that the coke charge shown in table was exclusive of bed charge, asked what was the additional cost of the 100 per cent. mixtures, because much depended upon results, and one could not expect to get a better material at a reduced cost.

MR. HURST pointed out these mixtures were not suitable for ironfounders. The tables had been utilised to show the amount of carbon absorption. White iron had been used in all except No. 2, when silicon had been added.

MR. WILLIAMS asked how the lecturer would account for the big percentage of waste in lots one and three.

MR. HURST said that he could not now say the character of the scrap used for these experiments, which were made in 1912. Very often 75 per cent. turnings and 25 per cent. something else were used. When dealing with turnings, as in the 40-ton melt, they were all quite clean, but he rather suspected the character of the turnings used in the other experiments.

MR. MCCLELLAND said that it seemed strange in using steel turnings, which are lighter and more bulky than rolled steel sections, that the loss should be so much less, 3.5 as against 8 per cent.

MR. HURST pointed out there were turnings in both, and it was possible that the turnings in one portion were bad, dirty and rusty. Replying to Mr. Colin Rees, he repeated that if one used pig-iron and got a certain analysis and then incorporated steel and produced the same analysis, and providing same are cast under identical conditions, then one would get the same properties. There is the question of dry and green sand moulding, etc., and a hundred and one details to be controlled to ensure the same results. This is an impossibility in practice.

MR. HIRD said that meant to say that cooling down and thickening of the casting played almost as big a part as the chemical analysis.

MR. HURST said that a metal poured hot would have a tensile strength of 14 tons, whilst one poured cold would only have a tensile strength of 9 tons. A 20 per cent. steel mixture would have 4 tons extra tensile strength. If the casting temperature is increased without any addition of steel, better results are obtained.

MR. HIRD suggested that if one wanted to get best results and could obtain really good iron and had the facilities to obtain the best brands of pig, it would be preferable to adding steel, if same results were obtained.

MR. HURST replied that he objected to paying the price for cold blast irons. Mr. Hird had suggested that cold blast iron had properties which were not to be found in other irons, but he (the lecturer) did not agree. The cold blast irons maintained their reputation in the roll industry, but it yet had to be demonstrated that cold blast irons had better properties. Emmel in his specification gives a 100 per cent. steel and claims 26 tons tensile strength per sq. in. Again, Keller, when making shells for the French Government by melting steel scrap and re-carburising in the furnace, obtained a tensile strength of over 30 tons per sq. in. France used to be large buyers of cold-blast irons, but since the coal strike synthetic irons can be bought at a price and roll makers are educated up to the fact that it is not essential to use cold-blast irons. It is practically a matter of roll makers having a chance of demonstrating some alternative.

MR. HIRD insisted that if one cast two test-bars from exactly the same iron, one would stand more than the other.

MR. HURST replied that this was not due to sulphur, but to the cooling conditions. An explanation of this would be found in THE FOUNDRY TRADE JOURNAL some time ago. White iron has no graphite, grey iron has graphite. Graphite forms at a certain temperature. Assuming the metal is solid at 1,150 deg. C., graphite forms at 1,145 deg. C. Graphite can be prevented from forming by virtue of the correct cooling. If metal is cooled sufficiently quickly, graphite does not form. The rate of cooling above 1,145 deg. C. can be anything, but it does not form graphite.

MR. MCCLELLAND proposed and MR. WILLIAMS seconded a hearty vote of thanks to the lecturer.

THE DEATH OCCURRED recently, at Cheltenham, at the age of 80, of Mr. Theobald Butler, a member of a well-known Leeds family, and formerly connected with the family undertaking at Kirkstall Forge.

The Foundry and Railway Charges.

By J. W. Parker, A.M.Inst.T.

Railway charges, always a substantial burden upon the heavy industries, have become more so since the 10 per cent. increase in rates became operative on February 1. It is true that the iron and steel industry has succeeded in avoiding the increase for the time being, but it is only postponed, and will have to be met at the end of three months. The enhanced charges have caused many firms to examine the entire rates question to see if any reductions can be made to counterbalance, in some degree, the effect of the advance. In carrying out this course, reference will first of all be made to the "General Classification of Goods," the official volume published by the Railway Clearing House, Seymour Street, London. It provides the only satisfactory approach to a proper understanding of rail rates and charges, and, as such, is well worth its purchase price of 1s. It divides some thousands of descriptions of goods into eight distinct classes, distinguished by the letters A, B, C, and numbers 1 to 5, commodities of great bulk or low value coming in "A," and the most costly merchandise falling in No. 5. "A" and "B" are known as mineral classes, the former covering coal, coke, sand and similar heavy goods, the latter taking in pig-iron, furnace lumps, furnace scrapings, filings, etc. A large range of goods is found in "C," such as firebars, brackets for carrying shaftings, coal conveyor parts, machinery shafts (unfinished), compressed and packed charcoal fuel, metal dross, founders' dust, unfinished flywheels, horseshoe moulds, brass foundry refuse, etc. The first class is responsible for light castings in boxes (iron or steel), malleable iron castings, iron and heavy steel and unfinished castings, and furnace rakes. In No. 2 are brass, copper, railway wagon brasses, bronze (phosphor or manganese), rough castings and anti-friction metals; No. 3 is responsible for brass or gunmetal castings, aluminium castings and light iron castings, while in No. 4 come wooden patterns for castings and aluminium (except such items as are included in class 3). For some materials what amounts to intermediate classes are authorised by the classification in that a percentage over or below certain exceptional rates is stipulated. Thus heavy iron or steel scrap is classified to take rates 10 per cent. in excess of the exceptional rates for pig-iron with a minimum load as for 4 tons. There is also a proviso that such figures shall not be more than the class "B" rate, nor shall they exceed exceptional rates laid down for the iron and steel list in class "C."

Choice of Classification.

In numerous instances, the same kind of goods may be in several different classes, depending upon the state of manufacture, packing, and other reasons. To illustrate the first-mentioned condition, shafts will serve for an example:—

Shafts for driving machinery, finished (owner's risk) .. .. Class 1
Shafts for driving machinery, unfinished (owner's risk) .. .. Class C.

If in sending these articles they are consigned simply as shafts, there is nothing to prevent the railway companies from charging class 1 rates, although the articles may be in an unfinished state. It is, consequently, important to use precise classification terms in describing all goods, otherwise loss will sooner or later be incurred. The influence of packing is shown by referring to aluminium castings, as follows:—

Aluminium castings, rough (not packed at owner's risk) .. .. Class 3
Aluminium castings, otherwise (packed) .. Class 4

Varying conditions are attached to the classes, a load of 4 tons being required for "A" and "B" and 2 tons for "C," the remaining classes being free from a weight stipulation. For most goods, when tendered in less than the required weight, a charge somewhat less than the next higher class rate is made. Thus "C" traffic in less than 2-ton loads is charged at 1s. 5d. less than the first-class rate, or for 2 tons at "C" rate, whichever works out the cheaper. For one or two commodities, however, it is specially provided in the classification that the full rate be maintained, iron and steel scrap being a case in point:—

Scrap, 4-ton loads .. .. Class B
Scrap, 2-ton loads .. .. „ C
Scrap, lesser quantities .. .. „ 1

Besides a charge for haulage, other elements are present in the rates. The charges in the numbered divisions cover loading, unloading, covering, station terminals, and general collection and delivery. In "C" the last-named service is not included, whilst in the mineral divisions labour is also absent. In "A" the wagon is not usually provided unless an additional amount by way of wagon hire is paid.

Having mastered the classification so far as it relates to the materials and goods one deals in, the rates may be sought either by asking the railway company to supply details of the figures in operation between all required points, or by seeing the station rate books for oneself. The railway will usually supply all information, but, failing this, it is as well to remember the rights conferred upon the trader by the Regulation of Railways Act, 1873, section 14 of which reads in respect of rate books:—"Every such book shall, during all reasonable hours, be open to the inspection of any person without the payment of any fee." It is hardly sufficient to make only one examination of the books, because those reduced figures known as exceptional rates often change, new quotations being frequently added to meet fresh trading conditions. Consequently, if not perused from time to time, it may easily happen that a new figure is overlooked, with resultant loss. Whereas in the past, individual firms negotiated with the railways when exceptional rates were required, it is becoming increasingly common for these operations to be conducted by a Trade Association on behalf of the industry as a whole, a method having undoubted advantages to both sides.

Lumping Together Small Consignments.

In the inspection of rate books, the first thing to be noticed is that the figures in most instances are not up to date, but remain at the pre-war level. It is thus necessary to take up the additions made since the war. Since February 1 last the addition has been 60 per cent. over pre-war, with a flat rate of 6d. per ton in the numbered classes and 4d. in class "C." In one respect, the percentage increase is not made direct, this being in connection with small parcels not exceeding 3 cwts. in weight. Owing to their being proportionately more costly to deal with than large

TABLE I.

Charged separately at "smalls" scale 36/8.					Up-to-date correct tonnage rate 36/8 plus 60 per cent. plus 6d. 59/2.		
cwt.	q.	lb.	s.	d.		s.	d.
	1	0	1	7	Charged together at 59/2 tonnage rate	11	9
1	0	14	4	3			
	3	0	3	1			
1	0	0	3	10	6 splits at 3d.	1	6
	1	14	1	10			
	2	0	2	5		13	3
4	0	0	17	0	SAVING	3s. 9d.	

consignments, a bonus is authorised by Parliament, which, together with the 60 per cent. increase, is incorporated in the "small parcels scale." Charges on smalls are thus determined by reference to the "smalls" scale, and not by calculation, as is the rule with larger lots. On the Scottish section of the railways, the bonus is rather higher, necessitating a separate scale, whilst in Ireland the different rates prevailing in Northern and Free State territory give rise to two more schedules. All the four are to be found at the end of the classification book. When

a sufficient number of smalls for different people in the same town can be accumulated so that the gross weight exceeds 3 cwts., a saving can be made by consigning them "part lot, charge together," when the whole will be charged as one consignment over the railway. An example of the economy obtained is given in Table I:—

Although this method necessitates the payment of a small amount for split delivery at destination, the possibility of saving will be apparent where any quantity of small parcels has to be dealt with.

The Import of Owner's Risk.

A further means of saving is available for a variety of goods when sent at owner's risk. Any articles classified under the letters X, Y, or Z and consigned at owner's risk become entitled to reductions of 10, 15, and 20 per cent. respectively. Patterns for castings in class 4Y under this arrangement save 12s. 11d. per ton where the full fourth-class rate amounts to 85s. 10d. per ton.

Similarly, furnaces for heating metals in 2Y are liable only at 53s. 4d. instead of 59s. 2d. Some allowance must, of course, be made for the added risk which falls upon the trader under the term of an owner's risk consignment note.

Exceptional rates being usually granted for large lots of traffic, it follows that small consignments cannot in the usual way obtain the benefit of these quotations. One way out of this difficulty is, however, provided by the "list" rate under which a number of articles are placed together under a generic heading. The iron and steel list takes in a large number of articles, all of which are eligible for any exceptional rates quoted for the "iron and steel list." Hardware and machinery also provide lists, both of which are of value to the foundry trade.

There is no power to compel railways to carry damageable goods when not properly protected by packing, but they are, as a rule, willing to accept them at owner's risk. The trader is thus able to make a saving in what might otherwise be expensive packing material, and the tare weight upon which carriage would have to be paid is also lessened.

Although the effect of the increased charges applying from February 1 is to advance rates by 10 per cent., the addition is made by taking the pre-war figures plus 60 per cent. In the case of rates granted during recent years which include the post-war percentage increase (gross rates), there is no pre-war figure available, so that the ordinary addition cannot be made. In such instances the gross amount is increased by 6 per cent., as adding 10 per cent. would give an incorrect result. There are, of course, comparatively few gross figures in existence, but it is none the less necessary to be sure that not more than 6 per cent. is added to them.

U.S. Blast-Furnace Industry in 1925.

Wage and cost data of blast-furnace and ferro-alloy establishments, not including establishments producing ferro-alloys in the electric furnace or zinc smelting plants making ferro-alloys as secondary products, are given by the U.S. Census Bureau in the following table:—

	1925.	1923.
Number of establishments	122	169
Wage earners (average number) (*) (†) ..	29,188	36,712
Maximum month ..	Feb. 32,421	June 39,767
Minimum month	Aug. 26,844	Jan. 31,777
Per cent. of minimum ..	82.8	79.9
Wages (†) (‡)	$45,312,168	$58,935,384
Cost of materials (including fuel) (‡)	$617,416,880	$827,629,665
Value of products (‡) ..	$765,286,229	$1,007,613,340
Value added by manufacture (§)	$147,869,349	$179,983,675
Horsepower	1,380,394	1,832,919

* Not including salaried employees.
† Statistics for wage earners and wages for 1925 are not strictly comparable with 1923 because some of the blast-furnace operators included data in their 1923 reports for wage earners engaged in relining blast furnaces, but did not include corresponding data for 1925.
‡ The amount of manufacturers' profits cannot be calculated from the census figures, for the reason that no data are collected in regard to a number of items of expense, such as interest, rent, depreciation, taxes, insurance, and advertising.
§ Value of products less cost of materials.

Foundry Plant at the Leipzig Fair.

Our representative at the Leipzig Fair writes that in the Machinery Hall there is little to interest the British visitor, insisting that the nature of the exhibits makes it apparent that the exhibitors are seeking business further afield.

Oil engines, mostly of the Diesel type, constitute the dominating feature of the Exhibition. These are shown direct-coupled to compressors or generators and also as independent units, practically the whole of them being shown under running conditions.

Of the few exhibits of direct interest mention may be made of the Demag display, which includes reduction gears of a very high order, and also a rotary compressor. The exhibit of Wagner & Company is of special interest to the foundryman, as in it are included several novel departures in moulding-machine design. There is also shown an efficient motor-driven sand mixer and aerator.

A large variety of oil-fired furnaces is shown for both heating and non-ferrous metal melting duties, but there is nothing particularly novel embodied in any of the designs.

In the Machine Tool Section there is probably assembled one of the finest and most comprehensive selections of machine tools which has ever been brought together. Upwards of 100 machine-tool works have contributed, and almost every type of machine tool is to be seen, including the heaviest metal-cutting and working machinery, wood-working machinery and optical precision measuring instruments. In this section the British market has certainly been well catered for.

Very substantially built cold-sawing machines are exhibited by Gebr. Heller, one shown being specially designed for use in the foundry for cutting cast-steel funnels and dead heads on large and bulky pieces of work. In this machine the saw is arranged in the horizontal position. A large variety of grinding machines is shown, while in this section are also to be seen wire-netting machines, nail, chain and nut and bolt-making machines, etc. The wood-working machines exhibited cover every requirement of the industry, from the circular and band saws to the most elaborate moulding machines.

It is particularly worthy of note that in almost every instance the machine is shown under running conditions, performing precisely the duties for which it was designed; the operations are not, as one usually finds at exhibitions, intermittent, but continuous as much as would be the case in the actual workshop.

The Continental Steel Trust.

The next meeting of the Continental Steel Trust is to take place in Brussels, when discussion will be resumed on the proposed development of the Trust by the formation of sale syndicates for various products. Whether the negotiations with the Polish makers will also be resumed at the forthcoming meeting has not yet been ascertained. On the latter question the general director of the Königs and Laura Hütte is reported to have stated that the existing agreement for the mutual protection of home markets, which now exists between the Polish works and those in Czecho-Slovakia, has been extended so as to include the Austrian and Hungarian works and to have been prolonged to October 31 next. The agreement can be determined by giving a month's notice or be automatically prolonged for half a year; it guarantees the contracting parties protection in their inland markets against mutual competition and protects them against a reduction of prices in foreign markets.

As to the Continental Steel Trust, the director states that the Polish works still demand the grant of a production quota on the 1913 basis, in addition to 11 per cent. of the increase in the world output, or an allotment of altogether about 1,900,000 to 2,000,000 tons. Nevertheless the understanding which was reached at the recent negotiations in Düsseldorf between the Poles and the Trust is considered to be very important for future discussions. In order to facilitate matters the Poles have offered to renounce any claim to the compensation of $2 per ton for any deficiency in their allotted output. The director is reported to have added that the Polish works might be expected to sign the agreement in about a month's time.

Blast-Furnace Irregularities.

In the course of a Paper on "Blast-Furnace Practice," read recently before a joint meeting of the Staffordshire Iron and Steel Institute and the Birmingham Metallurgical Society at Dudley, MR. R. S. BETHELL pointed out that a blast furnace in operation was subject to many forms of irregularity, due to a variety of causes. Such irregularities required immediate detection and prompt measures taken for their rectification, otherwise a train of evils might follow. Probably the most common form of irregularity was due to the entrance of water into the furnace, either by way of a leaky tuyère, cooler or cooling plate, leakage from the tuyères being more frequent than from any of the cooling devices. Leakage might be due to burning or abrasion of the cooling device. There were several ways in which the leakage of water into a furnace might be detected. Very frequently a good furnace charger would give intimation that the gas at the furnace top was very "wild," and on the slag being flushed off, the appearance of the slag also indicated that water was entering the furnace from some point. The slag became dark in colour, showed a black crust, or appeared foamy or glassy. A look round the tuyères would frequently reveal the cause of trouble, as the water might be seen rising up in a jet form in front of the tuyère. Sometimes the leakage was not so easily detected. Dampness might be seen around the base of the cooler or tuyère. If the blast was taken off the furnace and a cold bar thrust through the peep hole to the nose of the tuyère, dampness would be seen on it when withdrawn.

Other derangements of the furnace (continued the author) are due to obstruction in the furnace occurring at different levels and attributable to different causes. Faulty blast distribution in the hearth is responsible for one irregularity in that zone. If the penetration of the blast is insufficient to reach the centre of the hearth, a conical pillar of cold stock surrounded by an annular column of activity is liable to form. If a bar be driven across the hearth from tuyère to tuyère and then withdrawn, it will be found to be red hot in two portions with a black portion intermediate. The obstruction, known as "pillaring," can be felt when the bar is thrust into the furnace. The remedy is either to increase the blast volume or decrease the tuyère area to obtain better penetration of the blast. Scaffolds form above the hearth level and depend upon the furnace walls more or less for their support. The stock refuses to descend regularly, and sometimes the movement of the stock may be entirely suspended. The furnace is then said to be "hanging."

Scaffolds are very prone to form on the bosh of the furnace, and are due to incrustations set up by a contraction of the fusion zone. In the event of "side scaffolding" occurring, the furnace usually begins driving down one side, that is, on the side opposite to that on which a scaffold has formed. This trouble can generally be corrected by charging blank rounds of fuel on the side which is descending freely and reducing the tuyère air also on the same side. If the scaffold persists after this treatment, a quantity of silicious material, such as flue cinder, with the necessary fuel but no flux may be charged on the side where the obstruction occurs. Generally this will have the desired effect. "Ring scaffolds" are much more serious in character. The furnace refuses to take its charges, the blast pressure rises, and the gas becomes thin, hot and scanty. The fusion zone should be raised by the application of cold blast for a time. This should soften the incrustation preparatory to "jumping" the furnace.

The furnace should be kept free from slag during a "hang-up," in order that tuyères and blast pipes may not be filled with slag when the scaffold comes away. After cold blast has been at work for a time the furnace should be "jumped," that is, the blast should be taken off suddenly, so as to relieve the pressure under the scaffold. This will usually bring away the scaffold and blast should be put on immediately. It may be necessary to repeat the "jumping" operation several times before the obstruction is finally dislodged.

On some occasions it may be necessary to remove all the cooling system from the slag notch, and by means of full blast blow out the stock from underneath the scaffold. The weight of the superimposed stock is then generally sufficient to cause the obstruction to fall away when the blast pressure is removed. Dynamite has been used in some instances to remove a pertinacious scaffold. Other causes of scaffolding are improper fluxing, too heavy a burden, furnace design, and change in composition of materials.

Wedging of the stock in the upper regions of the furnace is likely to occur. This is assumed to be due to carbon deposition causing a large increase in the volume of the stock. The flow of the gases is also hindered by the finely-divided carbon deposited in the interstices of the stock. Both factors tend to cause hanging. The materials under the wedged portion of the stock commence to settle, and ultimately the "wedge" falls away or slips, causing an explosion of more or less violence. These explosions are more of the nature of a prolonged blow, but they frequently eject some of the stock and occasionally displace the bell and hopper. In cases of persistent "wedging," it is advisable to blow down the furnace to a good depth, even as far down as the bosh, then charge a heavy coke blank and fill up on light burden. The blowing down clears out the bulk of the finely-deposited carbon, and gives the furnace an opportunity to take up its normal rate of driving.

The most serious disorder that may befall a furnace is that of a chilled hearth, and is due to an insufficiency of heat in the hearth from whatsoever cause it may arise. All blast-furnace irregularities tend to cause a chilled hearth to a greater or lesser degree. The effect may be sudden, due to heavy flooding by water leakage or to the sudden precipitation of a mass of cold material from another part of the furnace. In severe cases of chilling the iron and slag may become so cold that they will not flow or they may even solidify entirely. Obviously, the only remedy is to raise the temperature of the hearth to the melting point as soon as possible. The burden should then be lightened, and a heavy blank of coke administered. If the ordinary tapping hole cannot be opened in the usual manner, an attempt should be made to tap out the iron at a higher level. Should this fail, preparations should be made to run iron from the furnace *vid* the slag notch. The peepie and coolers are withdrawn and the cavity filled up with bricks and clay, leaving an opening through which the iron and slag may issue. Whilst the iron is being temporarily cast through the slag notch, efforts should be made to open the tapping hole by means of an oil blow pipe, electric arc, or oxygen gas. The latter method is now almost universally adopted as being the quickest and most easily manipulated. As the hearth gradually recovers its heat, the bottom will gradually move downwards towards normal level, the tapping hole being lowered to correspond.

In some cases of severe "slipping" the whole of the hearth may become practically solidified to well above the tuyère level. Fortunately, such instances are not of very frequent occurrence, but when they do occur it taxes all the resources of the furnaceman to recover the furnace. The tuyères are all bunged up, and there is not an opening into the furnace for the admission of blast. Immediate steps must be taken to open a passage into the slag notch from an adjacent tuyère, or a tuyère and cooler must be withdrawn and a passage cut to the next tuyère. Blast is put on, and if there is an insufficiency of fuel to melt the solidified material, an oil supply must be led to the nose of the tuyère by means of a pipe passed through the peephole of the blast pipe. Persistent effort has its reward in time, and gradually the blast breaks its way upwards through the stock. When this occurs the slag notch should be closed to retain the slag and conserve heat within the furnace. In turn, extending in oth directions from the slag notch, each tuyère is brought into operation as the solidified material melts in its vicinity. The iron is cast through the slag notch until the tapping hole is finally recovered.

XUM

Belgian Foundrymen to Meet at Brussels.

The annual meeting of the Belgian Foundrymen's Association is to be held on April 9 and 10 at the Société Belge des Ingenieurs et des Industriels, under the presidency of that popular foundryman, Monsieur Ropsy. The Congress opens at 10 a.m., when the American Exchange Paper, written by Professor O. W. Polter (of the University of Minnesota) on the subject of "The Thermal Treatment of Grey Iron and Semi-Steel," will be read. The afternoon session, at 2.30 p.m., is to have two papers, one by Mr. A. Soupart on "Professional and Technical Training and the Foundry Industry." The second is by Mr. H. Fabre, who presents his Paper on behalf of the French Association, and deals with the "Manufacture of Large Grey-Iron Castings."

On Sunday morning at 10 o'clock, the President is presenting a Paper entitled "A Contribution to the Study of Carbon in Cast Iron," whilst the final Paper is by Mr. J. Ferdinand Kayser, of Sheffield (presented on behalf of the Institute of British Foundrymen). He has chosen for his subject "The Manufacture and Utilisation of Ni-Cr-Fe and Co-Cr-Fe Castings."

At 1 o'clock there is to be a luncheon at the Hotel Metropole, tickets 80 francs each. All members of the Institute of British Foundrymen are invited to take part in the Congress.

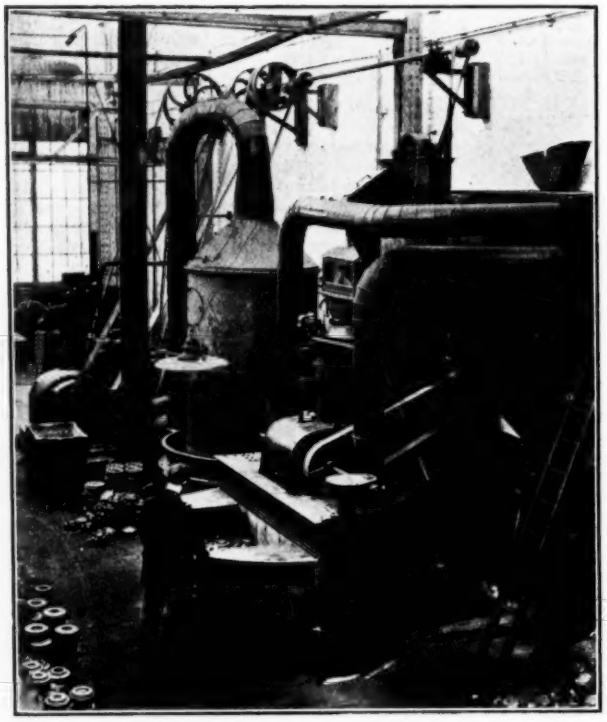
Sand-Blasting of Steel Stampings and Forgings.

Although it has been for some time a common practice to use the sand-blast process for the cleaning of castings, both in ferrous and non-ferrous metals, it has not been widely recognised what advantages can be obtained by sand-blasting forgings or stampings which have to be machined. It is a well-known fact that the greatest wear on cutting tools, especially milling cutters, is brought about when getting through the outer skin of the forging, and this point is especially important when dealing with high-tensile steels. It follows, therefore, that if this outer skin can first be removed by any other means, the cutter life is increased appreciably, thereby saving tool-room costs, always an expensive item.

It has been proved in practice that, at a working air pressure of 45 lbs. per sq. in. and using steel grit as the abrasive, stampings having a tensile strength of from 65 to 70 tons per sq. in. can be delivered to the machine shop with every particle of scale removed and having a surface which enables the cutters to be worked at their maximum efficiency right from the start.

The output that can be obtained depends very much on the shape of the forging and the type of sand-blast machine employed. Recently at the works of Messrs. the Associated Daimler Company, of Walthamstow, a rotary-table type machine, carrying a table of 87 in., has been installed, and it is employed on high-tensile steel stampings, and also castings, the output tonnage varying according to the class of work and the air pressure used. The gain in the life of the cutting tools has been very marked, and this naturally has increased the effective working time of the machine hand, as cutters have not had to be changed so often.

In conjunction with the table, a compressor capable of working up to 60 lbs. per sq. in., an exhaust fan for the removal of the dust, and a special dust-separating and exhaust installation were supplied, by means of which not only is no dust apparent in the shop, but practically none is passed out on to the roof, as it is all trapped in a special type of dust collector working in conjunction with a water tank, thereby ensuring a perfect seal.



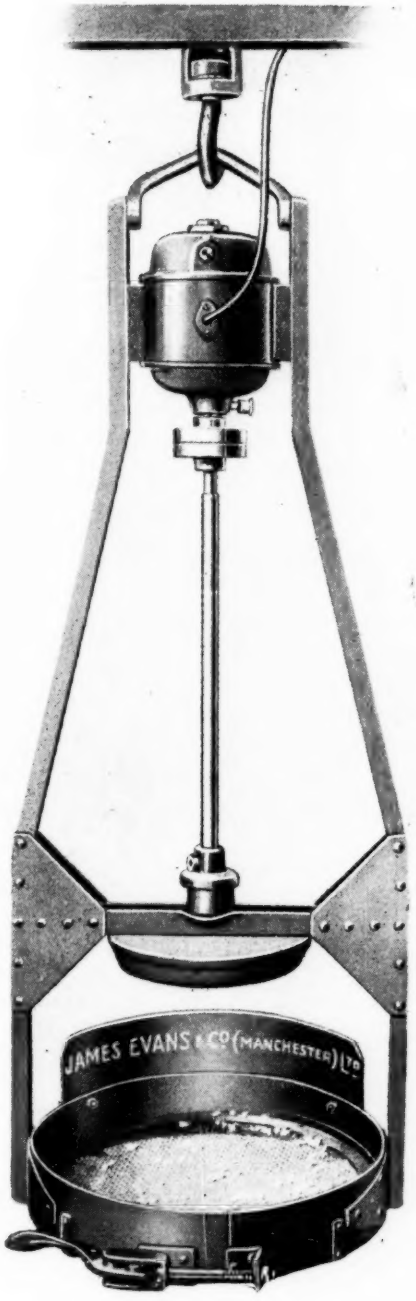
A Rotary-Table Type Sand-Blast Machine at the Works of the Associated Daimler Company, Walthamstow.

The layout of the plant is clearly shown in the illustration, which we are able to insert with the kind permission of Messrs. the Associated Daimler Company. The plant was manufactured and supplied by Messrs. Alfred Gutmann, of Hamburg, whose British and Dominion agents are Messrs. T. Fearnley Allen & Son, 51, Norwich Union Chambers, Congreve Street, Birmingham.

Czecho-Slovakian Foundrymen's Annual Meeting.

To-day and Friday the fourth annual meeting of the Czecho-Slovakian Foundrymen's Association is being held in Prague under the presidency of Professor Pishek. A foundry exhibition is being held simultaneously in the grounds of the Prague Spring Fair.

EVANS'S ELECTRIC
GYRATORY FOUNDRY RIDDLE



THE saving accomplished by the use of our Electric Gyratory Riddle pays for the cost of the machine in a few weeks' time.

It will sift more sand with one operator than six men sifting by hand. In addition to this it mixes the sand better, and produces a better grade than hand labour.

The machine is portable and may be moved to any place in a few moments (where a hook for suspension is available and electric current in service) and set in motion instantly.

Motor and working parts are all above the sieve, thus preventing the sand from interfering with the operation of the machine.

Power required, ½ B.H.P.

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BRITANNIA WORKS,

BLACKFRIARS, MANCHESTER.

Trade Talk.

THE WORKS OF Grice, Grice & Son, Limited, metal rollers, brass and copper tube makers, etc., Nile Street, Birmingham, are being considerably extended and additional plant installed

THE REORGANISATION OF THE WORKS of Henry Bessemer & Company, Limited, in Carlisle Street, Sheffield, was completed in April last, but the general strike and the coal strike prevented any advantage being obtained by the more economical working of the new tyre plant.

OWING TO THE prolonged coal strike and the consequent impossibility of obtaining delivery of the necessary steel work, the construction of the new acid plant of the English Crown Spelter Company, Limited, has been delayed. However, good progress is now being made, and it is expected that the plant will be completed by the end of July.

THE COMMITTEE which has been appointed to investigate the position of William Beardmore & Company, Limited, met for the first time on Tuesday. The committee consists of Sir Gilbert Garnsey, Mr. F. A. Szarvasy, Mr. W. W. Paine, and Mr. P. E. Marmion, formerly manager of the Burma Corporation. The committee has been invited to make a complete investigation into the affairs of the company, and to make proposals for reorganisation, financial and otherwise.

BEFORE THE JUNIOR INSTITUTION OF ENGINEERS, on Friday, March 11, a paper by Mr. J. Wolstenholme on "The Design, Construction and Operation of the Cupola of an Iron Foundry" was read. The author dealt very thoroughly with his subject, and concluded with the remark that the efficiency of the most efficient cupola stated as a percentage of the heat units used in melting the iron to the heat units present in the coke was probably not more than 50 per cent., while the majority of cupolas probably had an efficiency of less than 20 per cent. Although much discussion had been given to the subject of recent years, he did not know of any prolonged research, and when it was remembered that the difference between 20 and 50 per cent. efficiency meant a saving of at least 7s. per ton of metal melted, or probably 8s. or 9s. per ton of castings produced, it would be recognised that the subject was one of considerable importance. A discussion followed the reading of the Paper, in the course of which Continental cupola practice was referred to many times. Criticisms of mechanical charging machines were offered, and receivers and carbon monoxide percentage were other topics round which the discussion centred.

Personal.

DR. C. H. DESCH, of Sheffield University, presented a Paper on "The Growth of Metallic Crystals" at their spring meeting.

MR. PAUL D. MERICA, Mr. Zay Jeffries and Mr. W. M. Corse have been re-elected respectively chairman, vice-chairman and secretary-treasurer of the Institute of Metals Division of the American Institute of Mining and Metallurgy.

MR. W. E. PRENTICE has been appointed commercial manager for Bolckow, Vaughan & Company, Limited, and will be responsible for the sale of all the products, with charge of the commercial department of the head offices and of the district offices. Mr. Walmsley will continue, as heretofore, his direction of the commercial policy.

Wills.

GEE, T. J., of Basing Hill, Golders Green, N.W., mechanical engineer	£36,352
JACKSON, R., of Cromwell Road, Patricroft, Lancashire, retired engineer	£5,347
ANTHONY, T. V., a partner in Henry Bath & Company, metal brokers, London and Swansea	£48,245

Obituary.

MR. GEORGE CAWLEY, who died on March 3, was a consulting engineer specialising in railway work. The deceased gentleman was born in 1848, and received his practical training in Lancashire. He was one of the original staff in 1873 of the Imperial College of Engineering, Tokyo, Japan; in 1878 he visited the leading mining centres in the United States and Canada, and from 1886-93 was editor-in-chief of "Industries." In the latter year he established a general consulting practice in Westminster, and acted as consulting engineer to the Imperial Japanese Railways for 20 years. Mr. Cawley invented an electric (self-generating) locomotive, and an "Electric-Horse" haulage system for canals.

Contracts Open.

Johannesburg, April 9. — 100 malleable cast-iron special meter boxes, for the Municipal Council of Johannesburg. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 4,370.)

London, E.2, March 29.—20-ton weighbridge, for the Board of Guardians. Mr. C. F. Jones, clerk, Administrative Offices, Bishop's Road, Bethnal Green, E.2. (Fee £1, returnable.)

Otley, March 31.—(5) Iron castings for year ending March 31, 1928, for the Urban District Council. Mr. C. F. Hodgson, surveyor, Council Offices, Otley.

Salford, March 25.—(2) 590 lin. yards of iron railing, for the Secretary of Education, Education Office, Salford; and (3) wrought-iron railings and ladders, for the City Engineer, Town Hall, Salford.

Company Reports.

Hadfields, Limited.—Dividend for year on ordinary, 2½ per cent., less tax.

Thomas Smith's Stamping Works, Limited.—Interim dividend, 6d. per share, less tax, on ordinary.

English Electric Company, Limited.—Dividend on preference shares for half-year ended December 31, 1926, passed.

Henry Bessemer & Company, Limited.—Net loss, £27,667; debit balance brought forward, £36,620; total adverse balance, £64,286.

Coltness Iron Company, Limited.—Dividend, 10 per cent. per annum, less tax, for year; to ordinary reserve funds, £60,000; carried forward, £98,593.

Leeds Forge Company, Limited.—Balance to debit of profit and loss account brought forward, £188,565; deduct profit for year, £162; debit balance carry forward, £188,403.

Barrow Hematite Steel Company, Limited.—Debit balance, £109,249; debit balance brought in, £83,875; total debit at profit and loss account, £193,124; transferred to general reserve, £100,000.

British Insulated Cables, Limited.—Profits, £607,853; brought in, £224,918. The directors propose to place £200,000 to final dividend ordinary of 10 per cent., making 15 per cent. for year, and carry forward £271,720.

English Crown Spelter Company, Limited.—Credit balance, £30,561; brought in, £5,672; available balance, £36,233; reserve fund and suspense account, £12,000; dividend, 10 per cent., less tax, £15,978; carried forward, £8,255.

Midland Electric Corporation for Power Distribution, Limited.—Net profit, £163,481; brought in, £30,963; available, £194,444; debenture interest, £22,280; depreciation, £30,000; reserve, £50,000; final dividend, 2s. per shares is proposed on old ordinary shares and 1s. 4½d. per share on new shares; carry forward, £31,133.

Bruce Peebles & Company, Limited.—Profit for year, £24,509; brought forward, £8,655; depreciation reserve account, £5,000; balance, £28,164; dividend, 7½ per cent. per annum on preference shares; no ordinary dividend; further dividend, 2½ per cent. for year, less tax, making up full 10 per cent.; dividend on ordinary shares, 10 per cent., less tax; carried forward, £6,811.

Howard & Bullough, Limited.—Year to end March 31 in future; final dividend on ordinary shares for ten months to be paid in May, after which quarterly dividends will be paid in August, November and February, and a final dividend in May. In case of preference shares dividend covering four months to March 31 will be paid in May, and, subsequently, half-yearly in November and May.

Shanks & Company, Limited.—Reduction in amount required for reserve for payment of income tax, £20,000; special depreciation of plant and machinery, £10,000; general reserve, £10,000; net balance at credit of profit and loss, £35,367; brought in, £19,552; reserve for dilapidation of South tubal works, plants, etc., £3,000; general reserve, £10,000; dividend on ordinary shares, 6 per cent. for year, £17,400; carry forward, £19,856.

Scottish Iron & Steel Company, Limited.—Profit, £35,185; interest on debenture stock, £3,332; debenture stock sinking fund, £19,168; balance for year, £12,685; transferred from special reserve fund, £1,715; appropriated preference dividend account, £14,000; dividend on preference shares, 6 per cent. per annum, less tax; no ordinary dividend; balances of profits appropriation accounts carried forward: Preference shareholders, £12,900; ordinary shareholders, £6,354; transferred from sinking fund account to depreciation account, £20,000.

No. of Alloy	Specific Gravity.	Melting Point °C.	Test Specimen.	Average Tensile strength Tons—sq. in.	Average Elastic limit Tons—sq. in.	Per cent. Elongation on 2 in.	Remarks.
4	2.75	643	Sand cast	6.5	4.5	4	A light copper alloy which is an admirable substitute for soft brass. Is very ductile, and has a high shock resistance.
			Chill cast	9.5	5.0	8–11	
6	2.98	615	Sand cast	13.0	8.5	4	A copper-zinc alloy which is very strong, easily cast and suitable for general purposes. It has excellent machining qualities.
			Chill cast	13.5	9.0	5	
6a	3.12	600	Sand cast	16.0	12.0	2	Stronger, but heavier than No. 6. Will take a very high polish.
			Chill cast	17.5	11.0	5	
12	2.83	629	Sand cast	7.0	6.0	2	A very reliable non-porous copper alloy. Is largely used for die-castings, as well as for sand castings.
			Chill cast	10.5	7.0	4	
38	2.88	622	Sand cast	9.5	6.0	5	
			Chill cast	11.5	5.5		
30b	2.72	645	Chill cast	9.0	6.5	13	A light nickel alloy which makes hard ductile castings, suitable for mathematical instruments, etc.

The above figures are average test results made on specimens cast to 1 in. diameter and machined at the centre to 0.564 in. diameter.

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F.T.J. 24/2/27

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TYPICAL ANALYSIS *(if necessary guaranteed)*
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VOLATILE „ „ **1 %**
MOISTURE under **1.50%**

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